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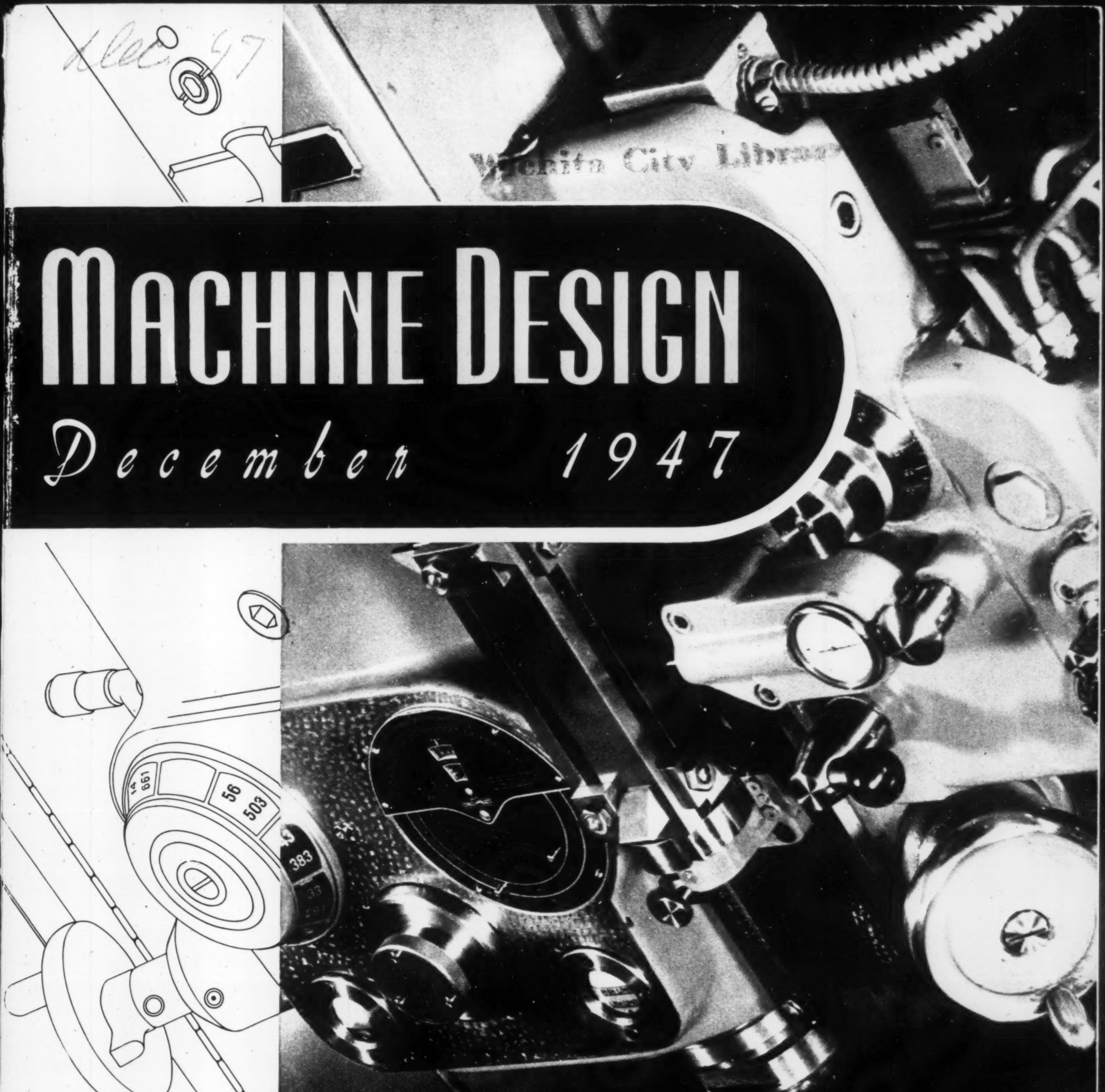
MACHINE DESIGN

December 1947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In This Issue: FORMING WIRE PARTS . . . STRESSES IN BOLTS . . . RHEOSTAT CONTROLS

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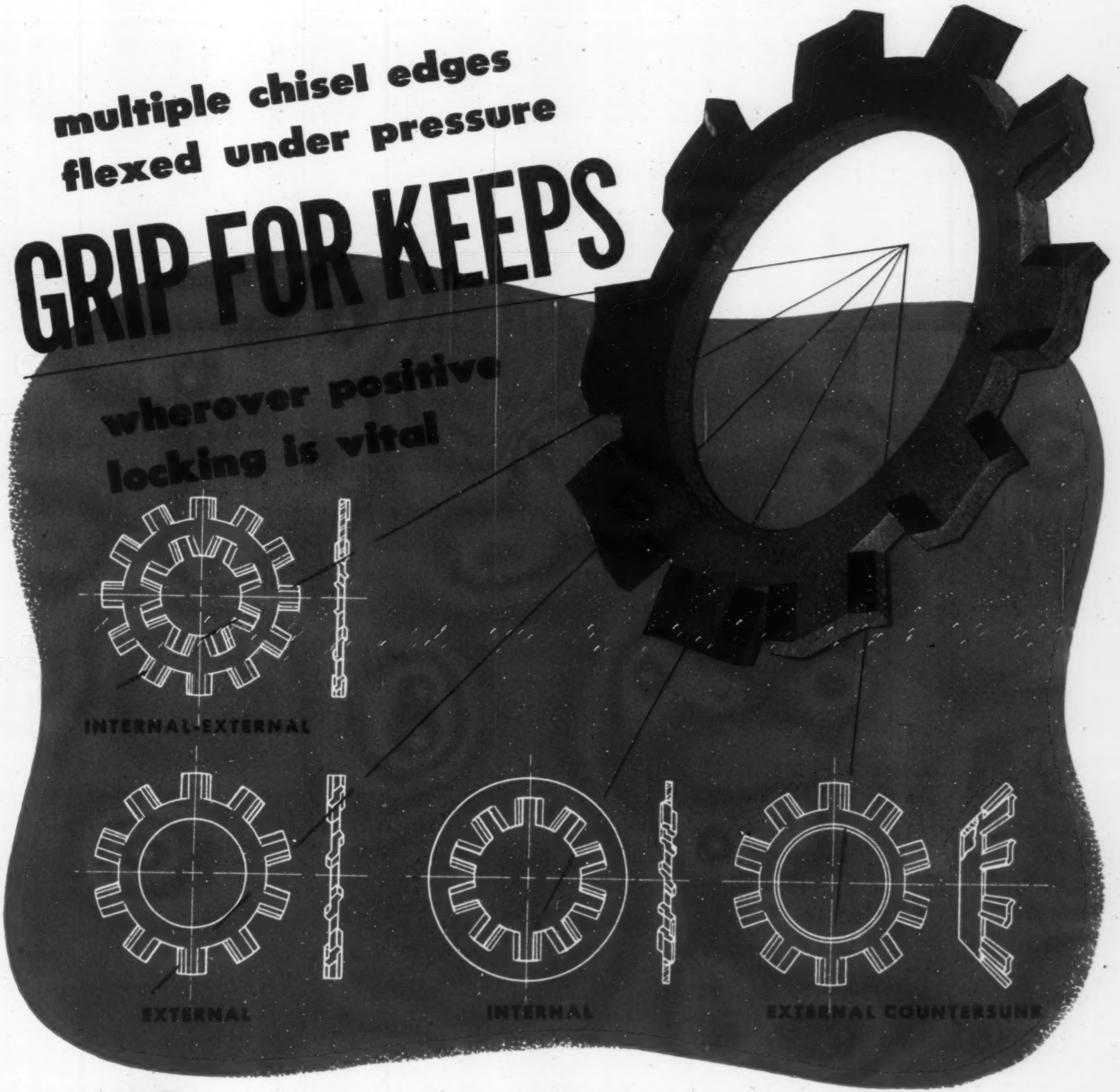
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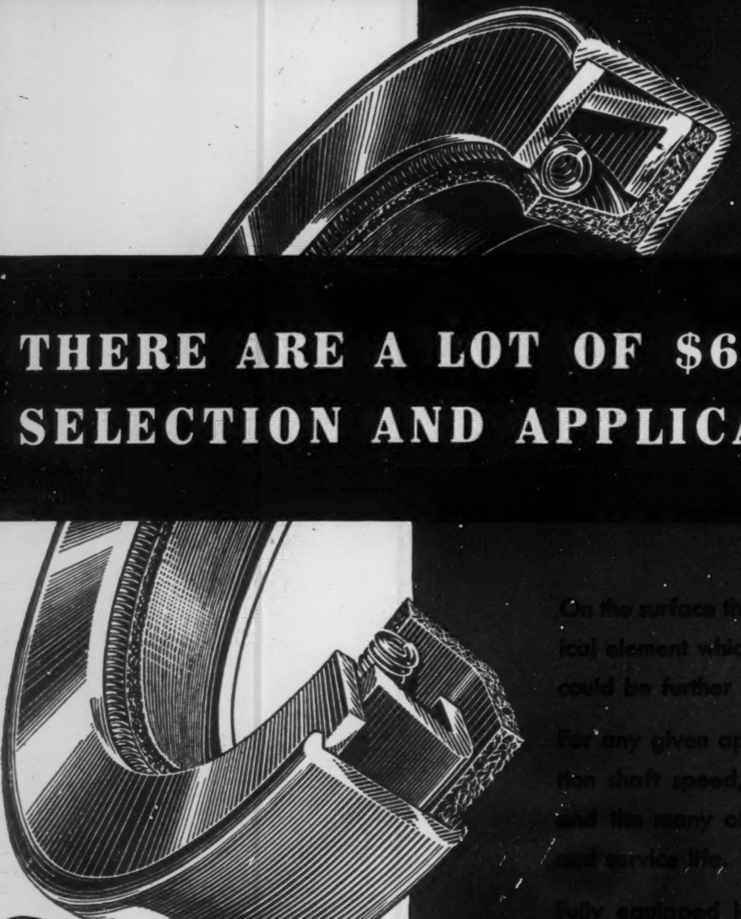

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This Month's Cover: Reproducing a single-throw crankshaft die on a Cincinnati Hydro-tel vertical milling machine. Cutting operations are synchronized with a hydraulic tracer head which follows the contours of a master pattern.

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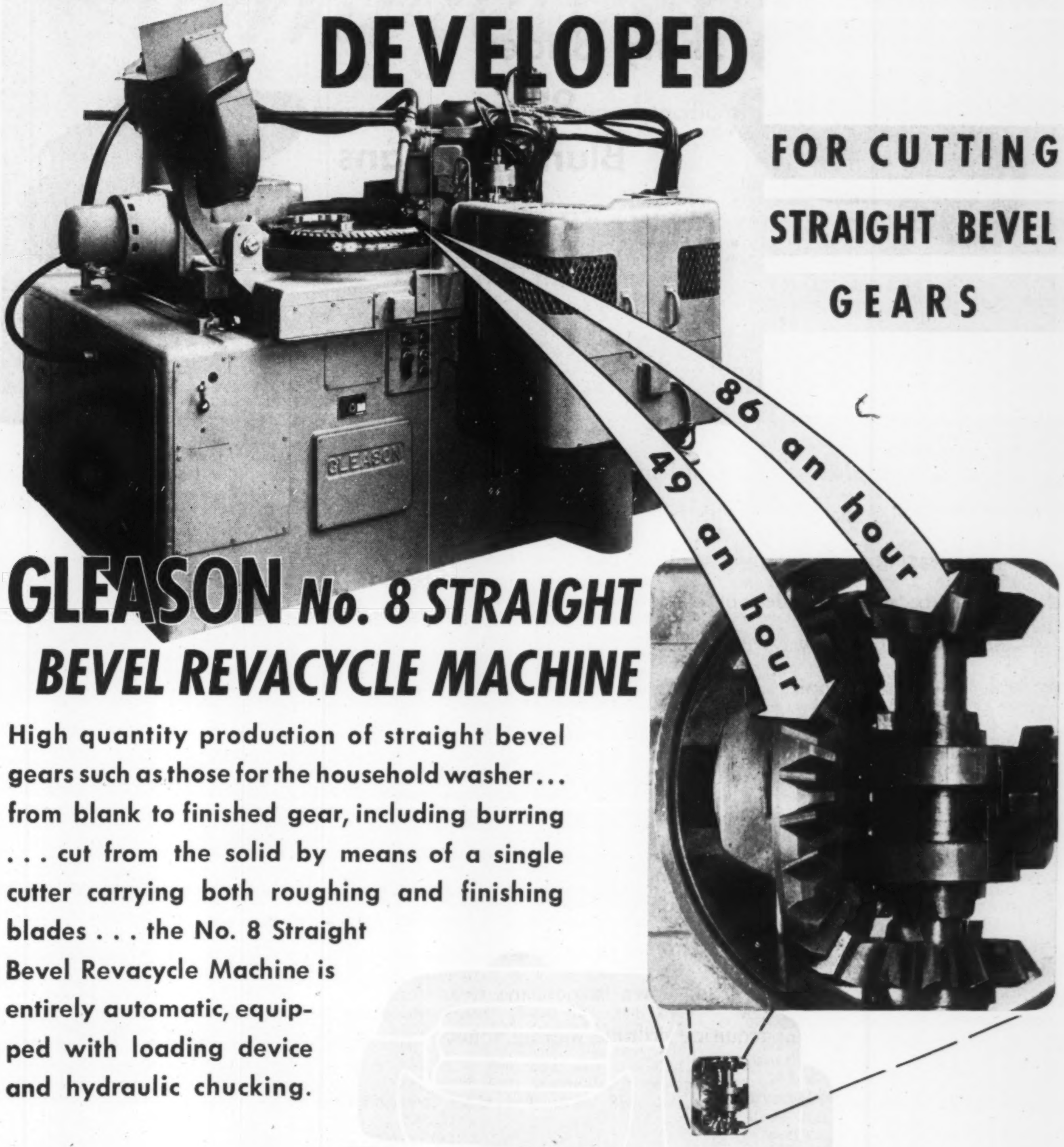

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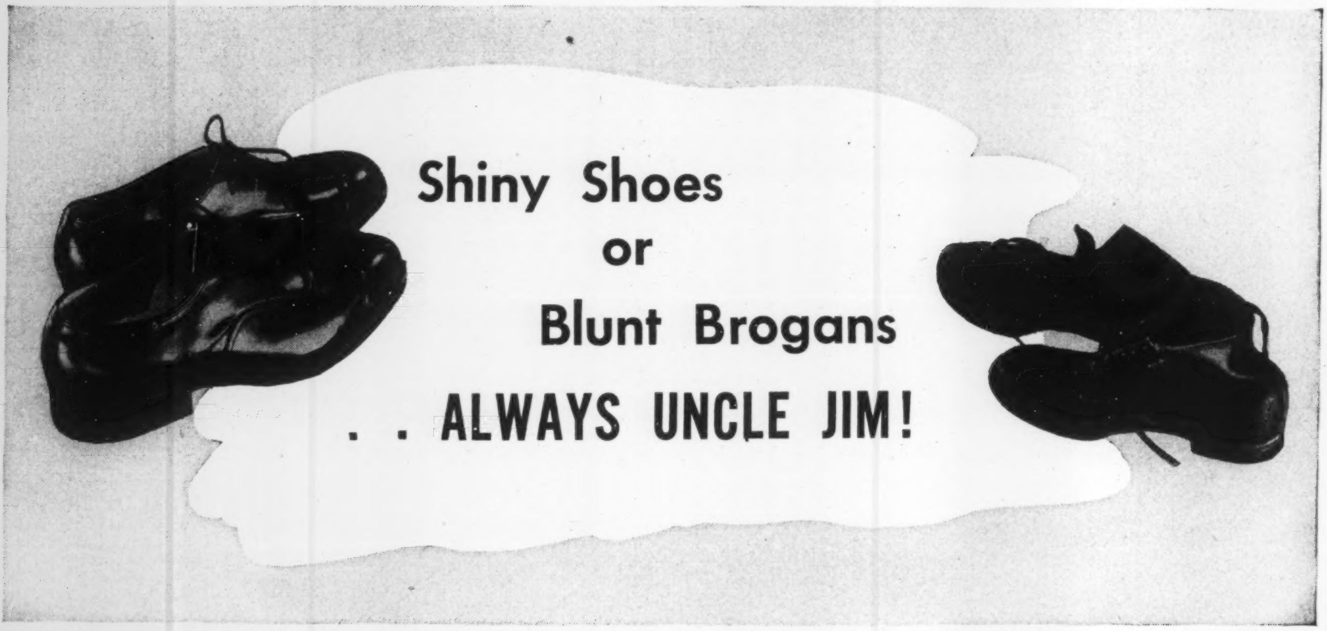

You could always depend on him to do things extra-well — whether slicked up in his best bib and tucker at a county meeting or working like a Trojan down in the south eighty — because, regardless of clothes he was always the *same Uncle Jim* — always doing things faster and a little better than most people.

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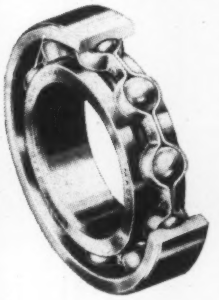
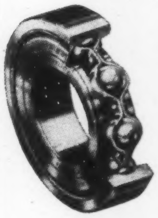


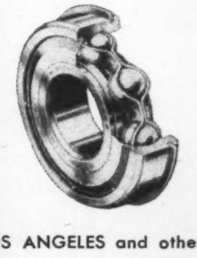
New Departure Single Row—Uncle Jim among bearings—always efficient — always in there working.



Single Row with shield on one side for protection against abrasive dirt.

With shields on both sides to keep dirt out and lubricant in.

With snap ring for simplified location in housing.



With snap ring and either one or two shields as required — *but always Uncle Jim!*

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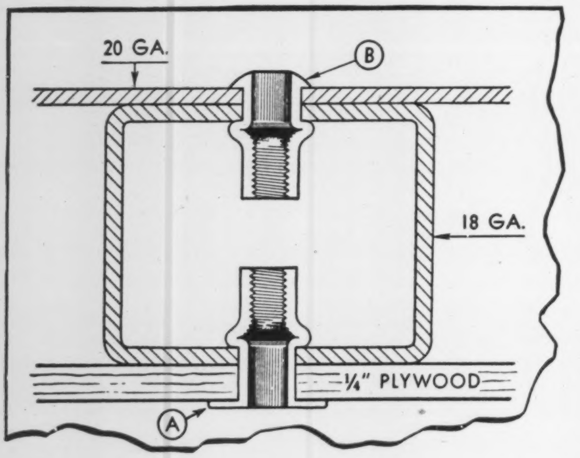

Trailer designers had the problem of securing ¼" plywood walls to 18 gage tubular steel sections with rivets that would not be pulled through the plywood under stress or vibrate loose in service. They found the answer in the new B. F. Goodrich Rivnut with the large washer head.

Washer-head Rivnut "A" is easier to install than either wood screws or self-tapping screws. The plywood can be countersunk so that the head of the Rivnut is flush with the plywood. Rivnuts eliminate the need for wood filler in the tubing. Brazier-head Rivnut "B" fastens either 1 or 2 sheets of 20 gage steel to the opposite side of the section.

Both Rivnuts serve as blind rivets. They can also be used as nut plates for fastening trim strips and other attachments. Because installation is done by one man, from one side of the work, in a few seconds, costs for the whole operation are reduced. If you have a fastening problem, chances are there's a Rivnut that will solve it. Why not get complete information? Write The B. F. Goodrich Co., Dept. MD-127, Akron, Ohio.

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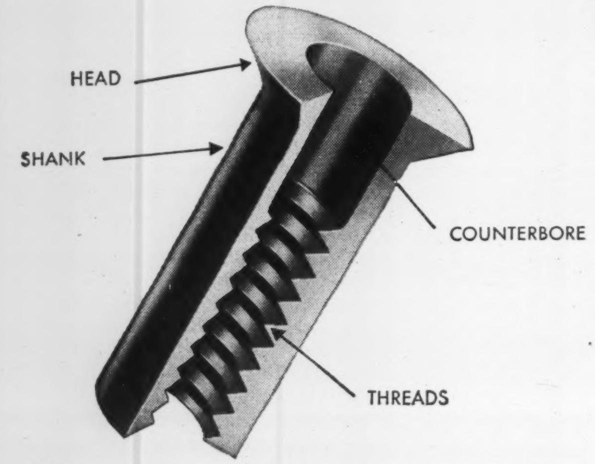
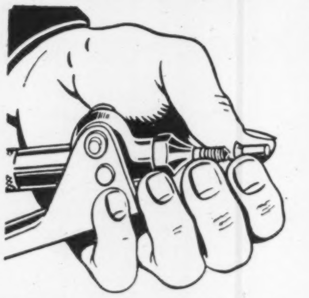


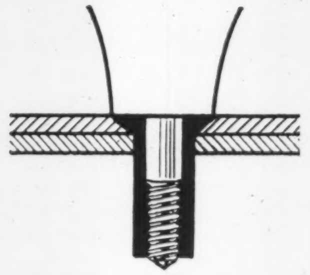
This cross-section shows the threads by which the Rivnut is threaded onto the pull-up stud of the heading tool. These threads are not injured by the heading operation and enable you to fasten *to* a Rivnut as well as *with* it.

Note counterbored portion in which lateral bulge is formed by pull-up action.

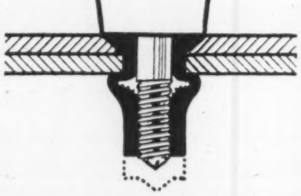
Countersunk-head type is illustrated. Rivnuts are also available with brazier head and flat head, in brass, aluminum, stainless steel and plated steel.



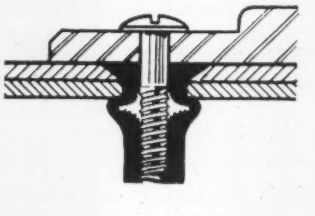
1. Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.



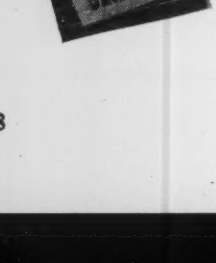
2. Rivnut is inserted—head firmly against work, tool at right angles to work.



3. Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.



4. After upset, Rivnut threads are still clean and intact, ready for screw attachment.



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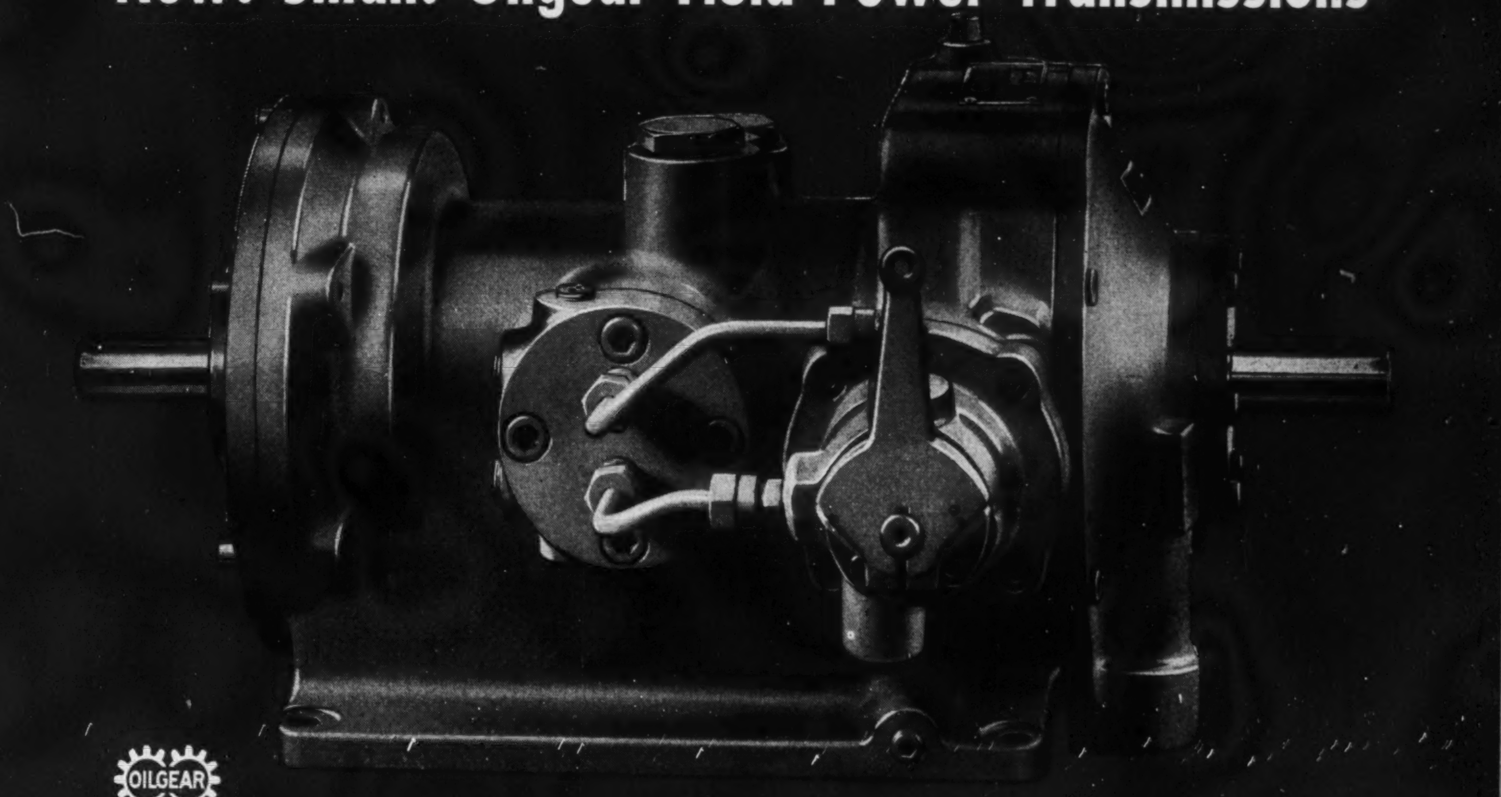

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They provide flexibility of location with convenient nearby or remote control and offer a choice of manual, electric or hydraulic controls. They provide quick, cushioned reversal . . . and a host of other advantages.

These transmissions are now used on starch machines, conveyors in many industries, wire rewinders, spring coiling machines, furnace drives, material supply pumps, gangsaw feeds, grinding wheel head drives and many other machines and processes. THE OILGEAR COMPANY, 1305 W. Bruce St., Milwaukee 4, Wis.

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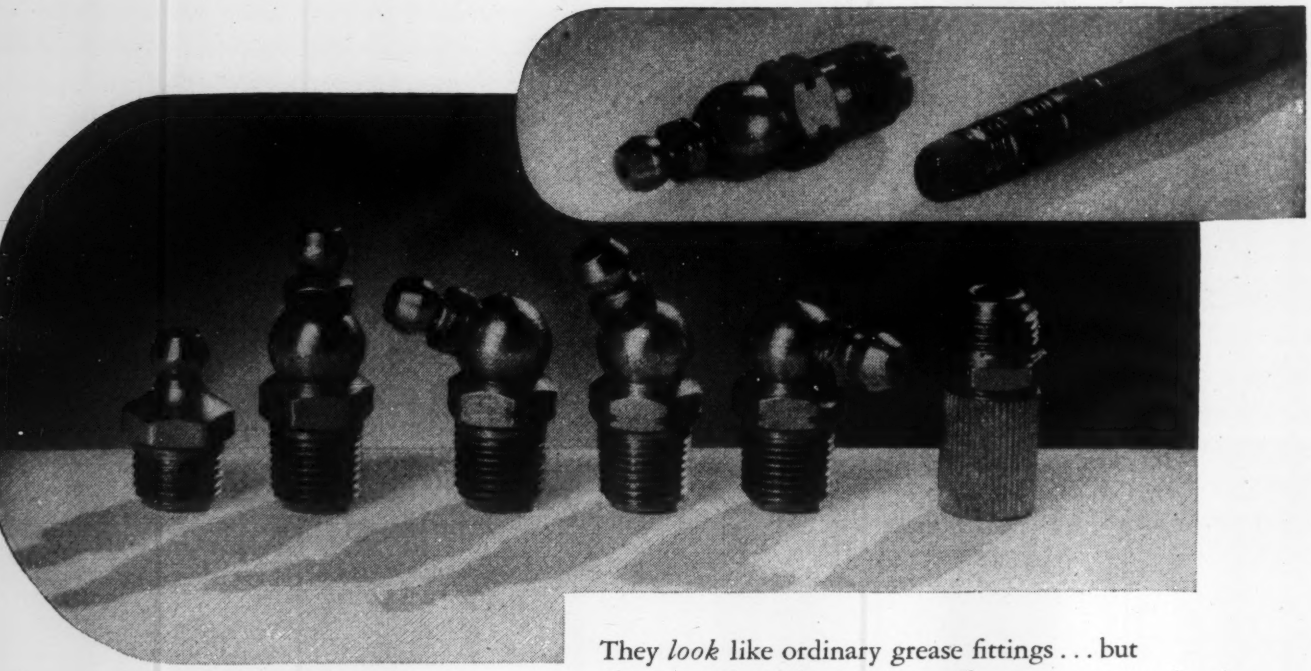


Short Story in metal selection

They *look* like ordinary grease fittings . . . but they're made of far sterner stuff.

These fittings are used on deck machinery and in corrosive industrial service. They cannot rust . . . corrosion won't plug 'em.

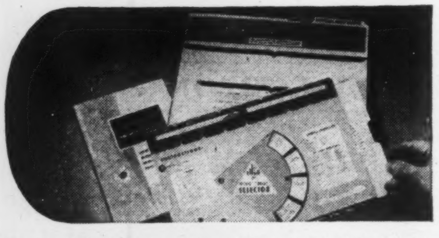
Each one is made of four different Inco Nickel Alloys . . . chosen for four different tasks.

Take the body of the fitting. It's threaded. So "R"* Monel is used for easy machining.

The tip, which fits into the mouth of the lubricating gun, must be hard and tough. Heat-treatable, easy-machining "KR"* Monel fills the bill here.

Inside, there's a heat-treated "K"* Monel stopper ball. Its hard surface will stay smooth and give good sealing for the life of the fitting.

And, keeping the ball tight against the opening, is a never-failing spring of Inconel*. A high modulus of elasticity gives this Inco Nickel Alloy the call here.



FREE METAL SELECTOR KIT! *Write for this handy kit. The slide rule selector tells you the important physical properties of the Inco Nickel Alloys. The booklet gives you 20 pages of tabulated comparative data on 104 ferrous and non-ferrous metals.*

WHENEVER YOU *have a tough job for a metal, give it to one of the Inco Nickel Alloys. They're the "task metals" of industry!*

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

INCO Nickel Alloys

Monel • "R"* Monel • "K"* Monel • "KR"* Monel • "S"* Monel Nickel • "L"* Nickel • "Z"* Nickel • Inconel** *Reg. U. S. Pat. Off.

EMBLEM OF SERVICE INCO TRADE MARK

"Task Metals" for Industry

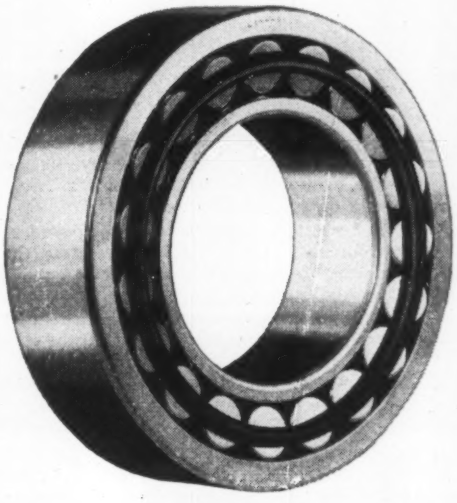
LINK-BELT "DE" SERIES

self-contained radial-thrust

Roller Bearings

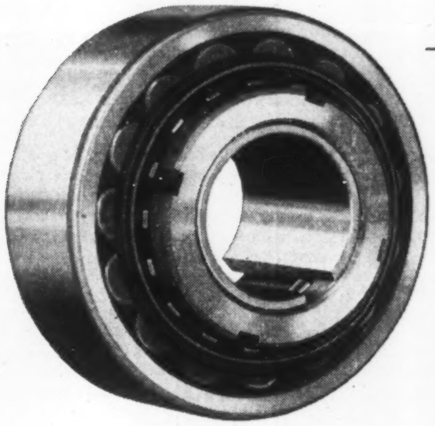
- -- high load carrying capacity
- -- no adjustment required
- -- self-aligning
- -- easily installed

One of the many stages of inspection in the manufacture of Link-Belt ball and roller bearings where accuracy and precision are assured.



Straight Bore Mounting

Series "DE" self-contained roller bearings for straight bore mounting are designed for press or shrink fits on shafting. They are turned and ground to precision diameters. This direct mounting of the bearing assures greatest smoothness in operation and increases its ultimate life.



Adapter Mounting

Series "DE" self-contained roller bearings for adapter mounting are designed for use with commercial shafting where ready means of removal and installation of bearing are advantageous. Tapered adapter sleeve supports inner race on shaft, providing a positive concentric mounting which adapts itself to commercial grades of cold finished shafting.

THE SYMBOL OF QUALITY LB LINK-BELT

LINK-BELT

BALL AND ROLLER BEARINGS

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Houston 2, Los Angeles 33, Seattle 4, Toronto 8. Offices, Factory Branch Stores and Distributors in Principal Cities.

10,887

NO. 2 IN A SERIES
"KNOW YOUR KENNAMETAL"
for
Design Engineers

"DESCRIPTION OF KENNAMETAL COMPOSITIONS"

SELECTING THE PROPER KENNAMETAL COMPOSITION is essential in DESIGNING FOR DURABILITY

The high degree of hardness, strength, resistance to wear, and other distinctive characteristics of Kennametal compositions show why they give superior service under heavy duty use, where strain, shock, heat, and wear are destructive to other metals.

Kennametal compositions may be divided into two general classes: Those consisting primarily of tungsten-titanium-carbide ($WTiC_2$); and those consisting primarily of tungsten-carbide (WC). Under each classification are two groups, as shown below, characterized by varying combinations of properties.

CLASS "A"—Group 1

High resistance to "galling," or "pick-up," due to its large content of $WTiC_2$. Moderate rigidity. Medium thermal expansion rates. The softer grades are the most shock-proof.

Grade KM (91.0 Rockwell A). Most widely used composition for steel-cutting tools. Combines properties of $WTiC_2$ with other refractory metal carbides, and optimum content of binder. Distinguished from straight tungsten-carbide-cobalt compositions by its "non-cratering" characteristic. When in contact with steel under high pressure and frictional heat, as in lathe tools cutting at high speed, the $WTiC_2$ composition resists "galling," or "pick-up," by the fast flowing hot steel chips. Likewise this property has been valuable in many other applications. Rolls of solid KM for rolling steel sheets to a smooth finish, are an outstanding example.

Grade K3H (92.0 Rockwell A). Contains highest percentage of $WTiC_2$ in the Kennametal series, and thus demonstrates in all its properties the characteristics imparted by this ingredient. Of all grades, it best resists "cratering." Not as strong as KM, but considerably harder, having lower percentage of cobalt binder. Resists oxidation at high temperature better than other standard grades.

Grade K5H (93.2 Rockwell A). Hardest steel-cutting composition. Contains high percentage of $WTiC_2$, with other carbides, and lowest percentage of cobalt binder. Combines high resistance to cratering and abrasion. Very strong for such a hard material.

CLASS "A"—Group 2

Moderate resistance to galling—medium content of $WTiC_2$. Compared to Group 1—better wear resistance where prevention of "galling" is not so important; higher resistance to thermal shock; greater rigidity; lower thermal expansion rates. The softer grade is more shock-proof.

Grade K4H (92.3 Rockwell A). A hard material, with low percentage of cobalt binder, and medium content of $WTiC_2$, thus combining some resistance to "cratering" with minimum edge wear. The uniform, sound structure results in a very strong composition for one possessing such high hardness.

Grade K2S (91.5 Rockwell A). Softer than K4H, having a higher content of cobalt binder, but with sufficient $WTiC_2$ to provide an important degree of "non-cratering." Used in tools requiring high shock resistance, as for interrupted cutting, or milling, and those for machining steel castings.

CLASS "B"—Group 1

High WC content. Excellent wear resistance where "galling" is not an important factor. Greatest rigidity. Very high compressive strength. Low thermal expansion rates. The softer grade is more shock-proof.

Grade K6 (92.2 Rockwell A). Primarily composed of tungsten-carbide with low content of cobalt binder. Has great strength for such a hard composition. Used widely for tools for machining cast iron, as well as for wear-proofing applications.

Grade K12 (89.0 Rockwell A). Consists primarily of tungsten-carbide, but contains a much higher percentage of cobalt binder. As a result, it is the strongest of the standard Kennametal grades, yet exhibits a high proportion of the properties of tungsten-carbide. More rigid than "K6," and the most shock-proof Kennametal composition. Used for rock-cutting tools. Not a metal-cutting tool grade.

CLASS "B"—Group 2

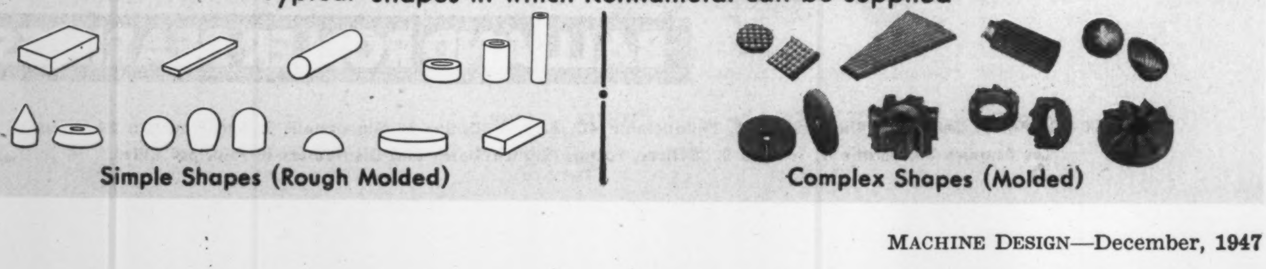
Special straight tungsten-carbide-cobalt compositions for extruded forms only. Adaptable to long slender shapes, primarily for wear-proofing applications. Produced in small rods of uniform cross section, or tubes, suitable for use in gage elements, pins, pivots, feeding fingers, guides, and small parts to which extruded forms can be adapted. These are not metal-cutting tool grades.

Grade KE5 (89.0 Rockwell A). **Grade KE7** (91.0 Rockwell A).

The mechanical and physical properties of Kennametal—hardness; modulus of elasticity; transverse rupture, compressive, and torsion strengths; specific gravity; etc.; application suggestions; and other useful data are fully discussed in our new technical bulletin—"Characteristics of Kennametal." A copy will be sent on request.

KENNAMETAL
TRADE MARK REG. U. S. PAT. OFF.
SUPERIOR CEMENTED CARBIDES
KENNAMETAL *Inc.*, LATROBE, PA.

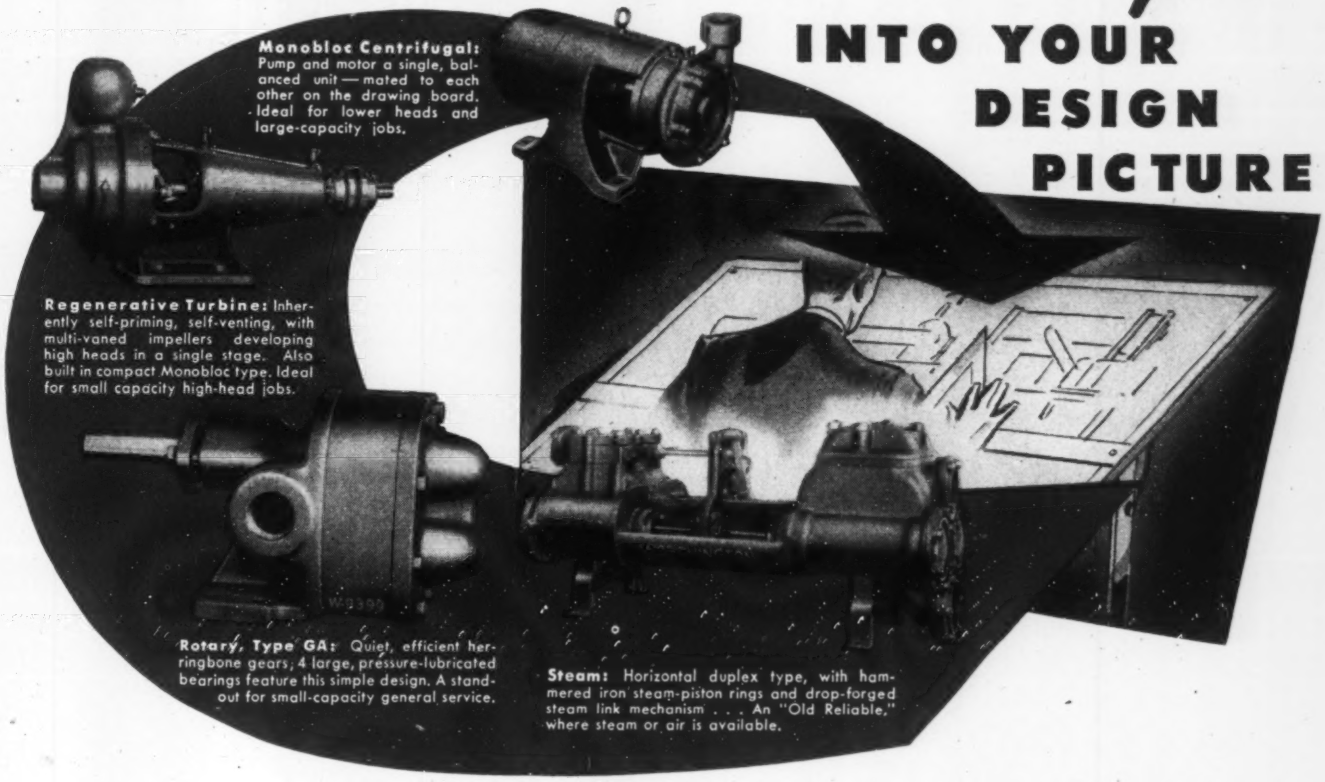
Typical shapes in which Kennametal can be supplied



Simple Shapes (Rough Molded)

Complex Shapes (Molded)

It's Easier to Fit Pumps INTO YOUR DESIGN PICTURE



Monobloc Centrifugal: Pump and motor a single, balanced unit — mated to each other on the drawing board. Ideal for lower heads and large-capacity jobs.

Regenerative Turbine: Inherently self-priming, self-venting, with multi-vaned impellers developing high heads in a single stage. Also built in compact Monobloc type. Ideal for small capacity high-head jobs.

Rotary, Type GA: Quiet, efficient herringbone gears, 4 large, pressure-lubricated bearings feature this simple design. A standout for small-capacity general service.

Steam: Horizontal duplex type, with hammered iron steam-piston rings and drop-forged steam link mechanism . . . An "Old Reliable," where steam or air is available.

. . . *when you specify Worthington*

Wherever your equipment design calls for pumps — call on Worthington! In the world's most complete line you'll find exactly the pumps that will team up with your plans to boost product-efficiency, customer-satisfaction — and sales!

The four leaders illustrated cover widely different uses — yet each shows the advanced engineering and rugged construction that assure consistent top performance and long, trouble-free service life.

Worthington Builds 'Em All!

Worthington builds pumps for every application . . . in all types and sizes . . . all heads and capacities . . . handling a great variety of liquids. And backing up every one, the longest and broadest experience in the field is at your service in selecting the right pump for every job . . . another reason why *there's more worth in Worthington.*

To learn how profitably Worthington pumps can fit into *your* product-picture, contact your nearest Worthington District Office or send in coupon below. *Worthington Pump and Machinery Corporation, Merchandising Division, Harrison, New Jersey. 36 District Offices throughout the U. S. A.*

MEMBER

WORTHINGTON

B7-6

PRODUCTS BASED ON MARKET RESEARCH

Centrifugal Pumps • Rotary Pumps
Steam & Power Pumps
Vertical & Horizontal Compressors
Multi-V-Drives
Variable Speed Drives

WORTHINGTON PUMP and MACHINERY CORP.
Merchandising Division
Harrison, N. J.

Send latest bulletin on Monobloc Pumps ( ); Regenerative Turbine Pumps ( ); Rotary Pumps ( ); Steam Pumps ( ).

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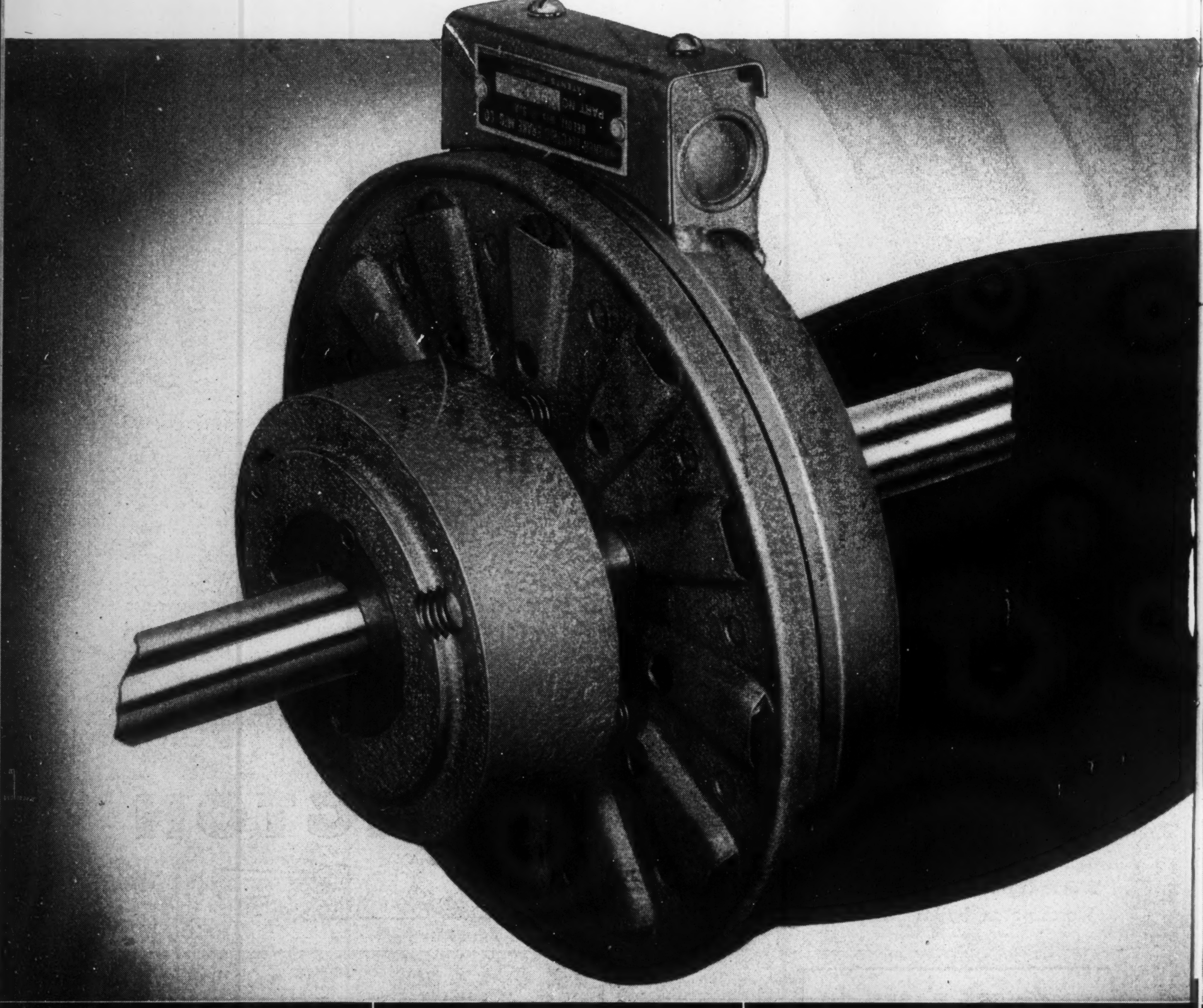
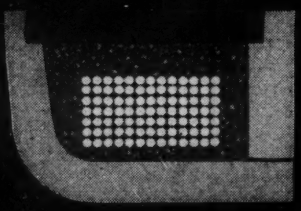
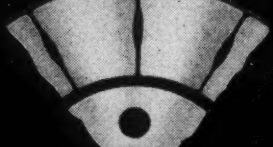
IT'S A CLUTCH - IT'S A BRAKE





MAGNET SECTION

Consists of a unique electro-magnet design faced with a selected molded friction material. Power is applied through coil shown solidly embedded below friction facing.



ARMATURE SECTION

Wear surface made up of segments of magnetic material welded to steel back plate. Expansion of segments, caused by heat of clutch or brake action is linear, keeping armature in full contact with magnet. Heat has little effect on operation.

TYPICAL ICB INSTALLATION

This typical installation shows simplicity and compactness of clutch-brake unit, ease and flexibility of assembly to machinery.

IT'S THE *New* WARNER "ICB UNIT*"

THIS STARTLING DEVELOPMENT offers you advantages never before incorporated in an electric brake or clutch unit

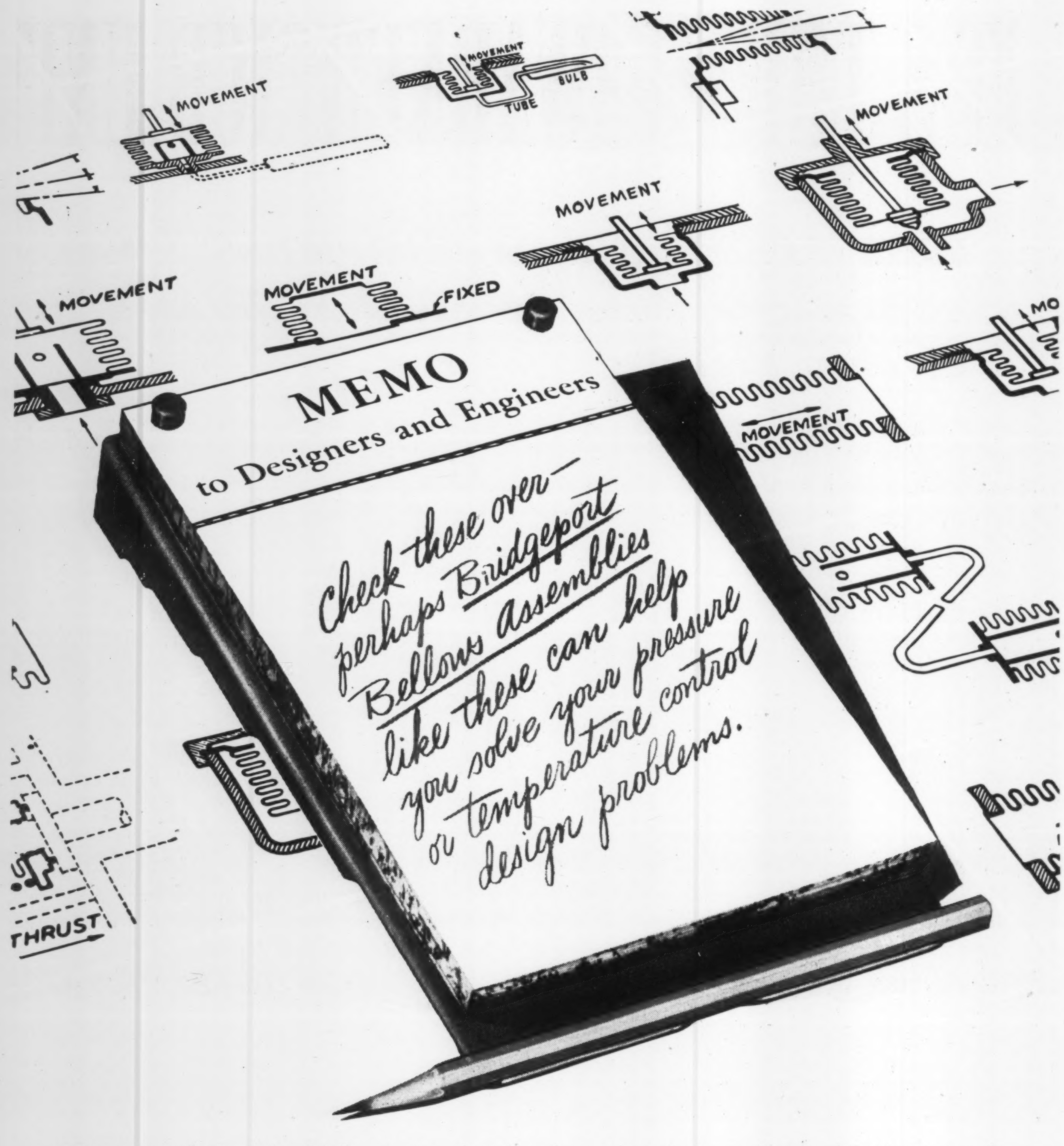
1. **OPERATES INSTANTLY** — Lightning fast action! . . . it operates electrically. No gaps to close or slack to take up. No hinges, adjustable springs, lever actions, cams or solenoids to cause a "lag". Action starts when current is applied.
2. **NEW SUPER STARTING OR STOPPING POWER** — The secret of this new power is the fact that it utilizes not only ordinary friction, but in addition uses the power of electro-magnetic attraction between its ring-shaped electro-magnet and armature disc.
3. **INFINITE CONTROL** — Because the applied power varies with the flow of current through the magnet, the Warner ICB Unit offers a range of applications heretofore unknown. Clutch or brake action may be controlled to a fine degree, manually or automatically, as machine operating cycles require. Rectified power is supplied from 110, 220 or 440 volt A.C. source or 6-12 volt battery.
4. **CONSTANT SELF-ADJUSTMENT** — The armature disc rides in constant light contact with the friction surface of the electro-magnet. Where application requires, light spring pressure maintains this constant contact and follows up all wear between the two surfaces, thus eliminating the need for any mechanical attention.
5. **REQUIRES MINIMUM INSTALLATION SPACE** — The space required is such that it can be readily worked into the design of machinery. Four sizes are at present available: 8½, 10¼, 12½ and 15½ inches in diameter. The shaft length occupied by the armature and magnet unit of any of these sizes is less than 2½ inches.
6. **LOW COST** — The Warner ICB Unit has fewer parts for the same clutch or brake action than any other clutch or brake unit. This is reflected in cost. When the magnet and armature become worn after prolonged service, they are easily replaced at nominal cost. There are no lists of spare parts for the user to stock.
7. **UNMATCHED HEAT DISSIPATION** — The steel back plate of the armature disc is designed to act as a blower. This blower action dissipates the heat where and when it is generated.
8. **INFORMATION AND ENGINEERING SERVICE** — Warner Electric Brake Units have been successfully used for twenty years. The experience of these years of brake manufacture and application are yours for the asking. For detailed information on the Warner ICB Unit as a clutch or brake for machinery applications write the Industrial Engineering Division.

* ICB Unit—The trade designation for INDUSTRIAL CLUTCH OR BRAKE UNIT.

WARNER
ELECTRIC BRAKE MFG. CO.
BELOIT, WISCONSIN

Makers of Electric Brake Units since 1927

WARNER
ICB UNIT


MOVEMENT
MOVEMENT
BULB
TUBE
MOVEMENT
MOVEMENT
MOVEMENT
MOVEMENT
FIXED
MO
MOVEMENT
THRUST
MEMO
to Designers and Engineers
Check these over—
perhaps Bridgeport
Bellows Assemblies
like these can help
you solve your pressure
or temperature control
design problems.

● Many manufacturers in all industries have found the right answer to their design problems with a Bridgeport metal bellows, bellows assembly or device . . . like those shown in diagram above. You may solve your problem in the same way. For Bridgeport bellows devices are developed to meet *your* specific needs—are produced on order for *your* particular product. And, Bridgeport engineers help in their design and development—follow through to make *sure* you get *all* the performance promised. Sizes from $1\frac{5}{32}$" to 12" O.D.—wide range of metals. Write for Catalog XK-100; it contains complete information and *plenty* of ideas.

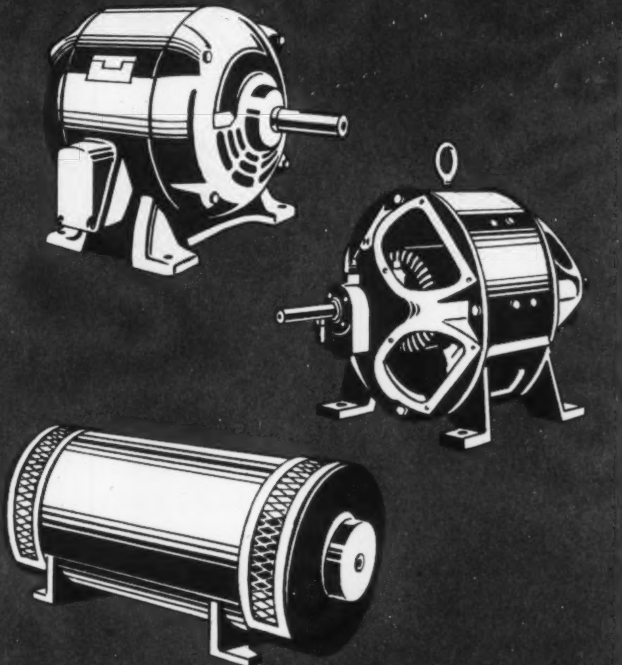
Bellows Assemblies . . . Bellows . . . Bellows Devices

BRIDGEPORT THERMOSTAT

Division

ROBERTSHAW-FULTON CONTROLS CO., BRIDGEPORT 1, CONN.

6 ways you can use
IMPROVED DRIVE METHODS
to produce
BETTER · FASTER · CHEAPER!

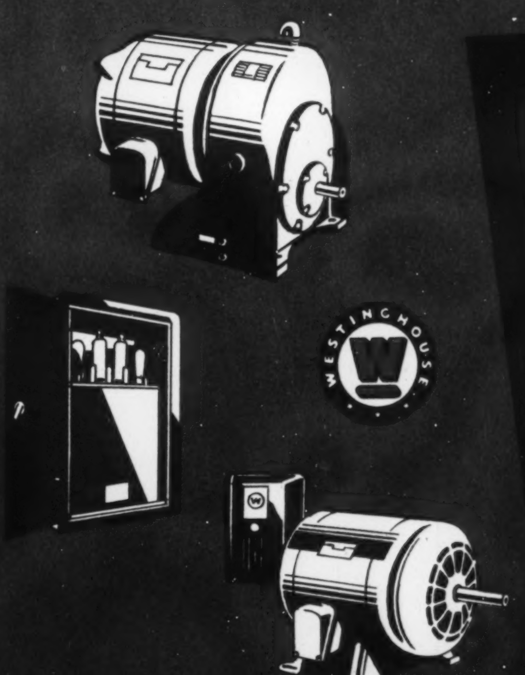


The application of improved drives to existing machines offers many practical possibilities for producing better, faster, cheaper. It involves no heavy investment in new machines or relocation of equipment, and no lengthy training of new operators.

Modern Westinghouse drives and controls—through co-ordinated engineering and application—can perform many timesaving, cost-cutting jobs not commonly credited to such equipment.

On the next two pages you will find proved ways these drives are helping manufacturers cut costs, save time and improve products in typical plants.

Westinghouse
PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE



FOR ANSWERS TO PROBLEMS LIKE THESE . . .

1. How can Variable-Voltage Drives modernize your control systems to give increased production at lower cost?

2. Does Rototrol offer a means of improving operating performance without the necessity of replacing an entire drive?

3. Are direct-connected Gearmotors the means of reducing your plant operating cost?

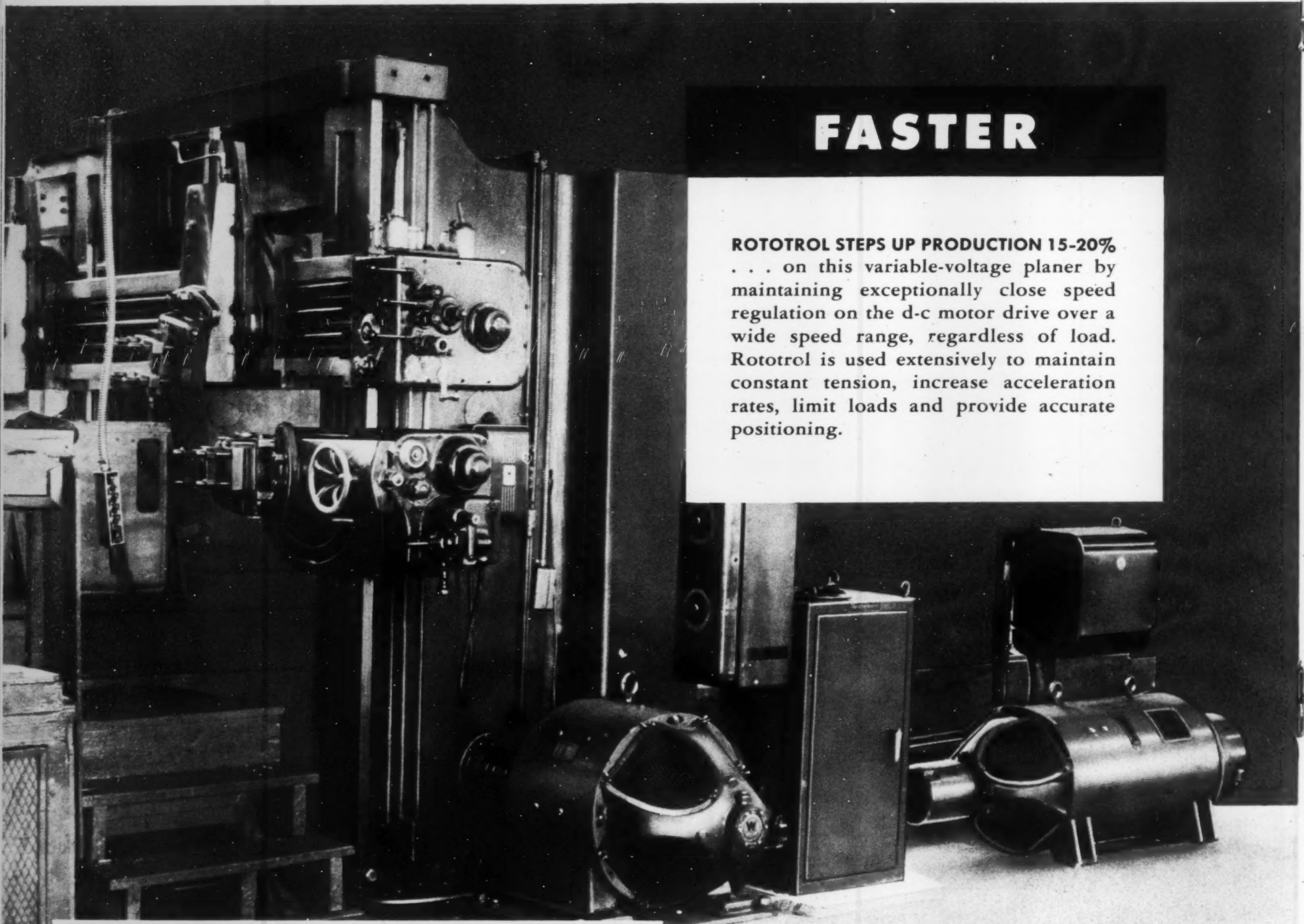
4. Is Mot-O-Trol your answer to lower operating costs through more accurate speed control?

5. Would motors that require "no lubrication for 5 years or more" solve one of your costly maintenance problems?

6. How can you improve product quality by proper drive and control selection?

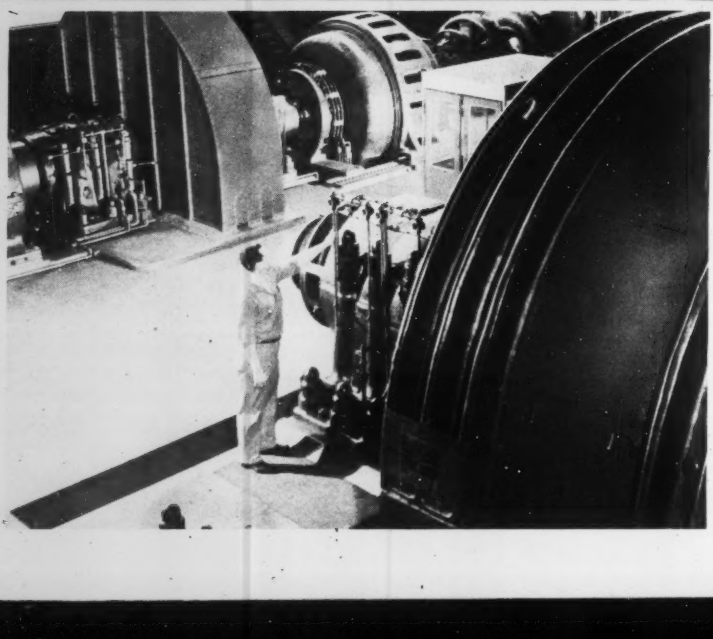
. . . turn the page

Here's how MODERN DRIVE *are being used* TO GET MORE PRODUCTIVE POWER



FASTER

ROTOTROL STEPS UP PRODUCTION 15-20% . . . on this variable-voltage planer by maintaining exceptionally close speed regulation on the d-c motor drive over a wide speed range, regardless of load. Rototrol is used extensively to maintain constant tension, increase acceleration rates, limit loads and provide accurate positioning.



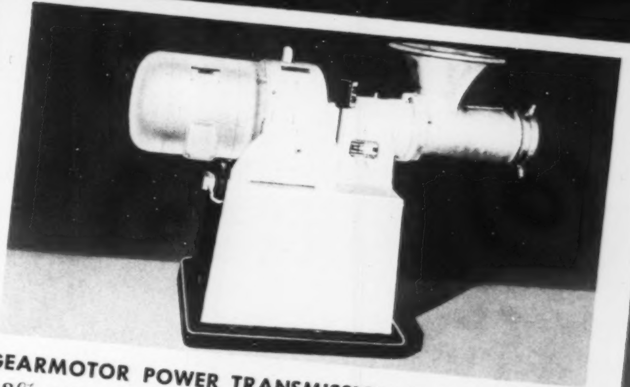
REVERSAL TIME SAVED, ROLLS 38 ADDITIONAL TONS OF STEEL PER HOUR . . . Installation of new exciters, Rototrols and control equipment on this 26-year-old Westinghouse 5,800-hp, d-c motor reduced reversal time to 1.7 seconds.

METHODS

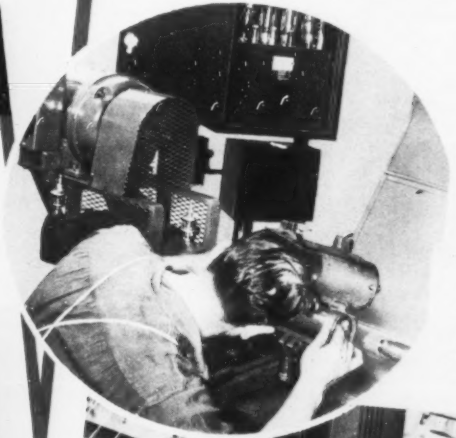
FROM PLANT MACHINERY

Greater precision, compactness, simplification of functions, less maintenance, higher quality of finished product . . . these are important dividends from the sound application of properly-designed drives. Change-over jobs on present equipment may not necessarily involve completely new drives to obtain the advantages of better, faster, cheaper production. The examples shown here are typical of results achieved in scores of plants through alertness to new drive and control developments.

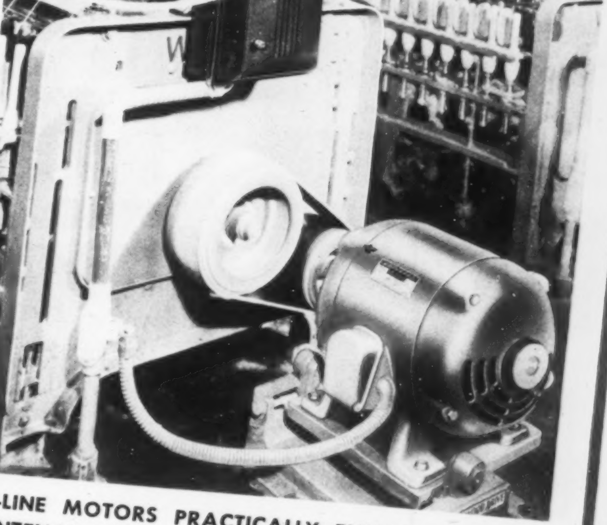
CHEAPER



GEARMOTOR POWER TRANSMISSION is from 23% to 38% more efficient than other methods of speed reduction . . . provides power and energy savings up to 10.5%...completely eliminates maintenance costs common with open gearing, belt, chain and rope drives.

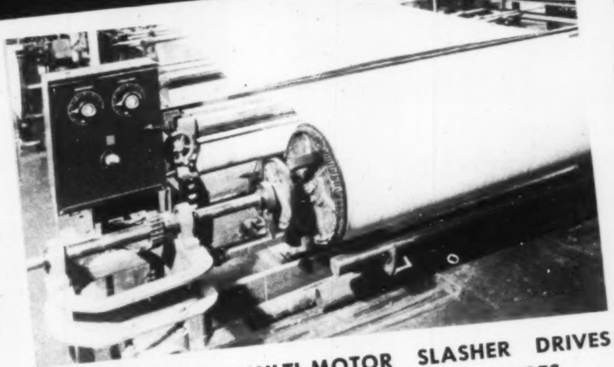


MOT-O-TROL SHOWED A 3-WAY SAVING on this grinding operation. Setup time was cut, chatter marks were eliminated and the improved drive method *saved 35% in floor space* over the previous cumbersome overhead controls.



LIFE-LINE MOTORS PRACTICALLY ELIMINATE MOTOR MAINTENANCE... Pre-lubricated, sealed ball bearings, requiring no lubrication for 5 years or more, mean no skipped bearings, no overgreasing, no lost pipe plugs and no lost production time due to motors out of service.

BETTER



WESTINGHOUSE MULTI-MOTOR SLASHER DRIVES PROVIDE IMPORTANT PRODUCT ADVANTAGES . . . uniform yarn tension, yarn diameter, beam density; better filler yarn spacing; less yarn breakage; more warp on the beam; fewer stops and adjustments . . . all pointing toward increased production, improved cloth quality and lower production costs. These are typical of the advantages to be gained in many types of production through use of specialized Westinghouse drives.

WESTINGHOUSE
W

FOR MORE PRODUCTIVE POWER . . . *LOOK TO*

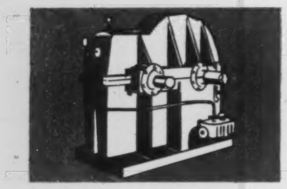
Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

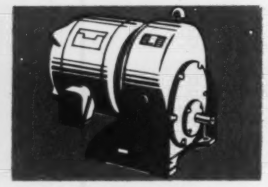
FOR MORE INFORMATION ON HOW TO MAKE POWER MORE PRODUCTIVE
TURN PAGE

FOR ANY DRIVE PROBLEM Westinghouse OFFERS

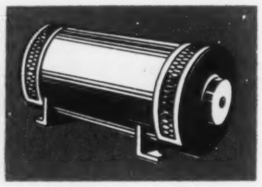
THE RIGHT EQUIPMENT..APPLICATION HELP



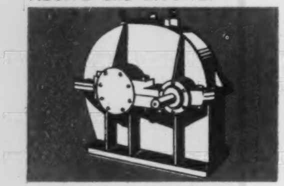
Speed increasers (Type SU) are produced in three basic styles comprising a total of 30 sizes. Small units have nine sizes from 1.25:6.50 to 1.25:12; large units have 12 sizes from 1.25:9 and 2.00:8 to 1.25:12 and 2.00:12.



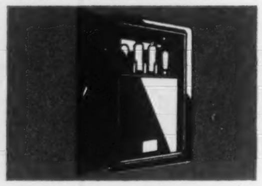
Gearmotors are available in three types—Type A, single-reduction with gear ratios from 1.22 to 6.25; Type C, double-reduction with gear ratios from 7.61 to 25.7 and Type E, double-reduction with gear ratios from 31.2 to 58.3.



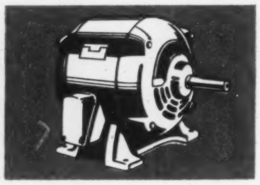
Rototrol for modern control systems where one or more of the following functions are to be controlled: speed, load, torque, acceleration or power factor.



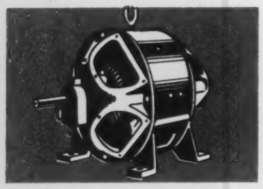
Speed reducers, in single and double-reduction units, have ratios from 2.82:1 to 9.5:1 and 11.8:1 to 70.5:1. All are external-geared type with shafts in horizontal plane.



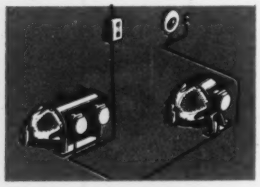
Mot-O-Trol electronic drives provide accurate speed control over a wide speed range from single or three-phase, a-c power. Ratings range from 1 to 10 hp.



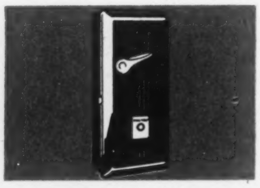
Life-Line motors—the greatest advance in motor design in 58 years—are built in 1 to 200-hp ratings, two and three-phase, for voltages of 208, 220, 440 and 550.



D-C motors—Type SK—a complete line of standard sizes, 1 to 200 hp, frames 204 and larger, 115-230 or 550 volts



Adjustable-speed, a-c drives have hp ratings of 1 to 15, inclusive, for 220-440 or 550 volts, 2 or 3-phase, 60-cycle operation. Speed range 10:1.



Combination Linestarters, Class 11-206, provide complete motor and circuit protection in one enclosure for motors up to 200 hp.

Mail coupon for more information

Westinghouse Electric Corporation
P. O. Box 868
Pittsburgh 30, Penna.

Please send me more information on the following products:

☐ **Speed increasers**
☐ **Speed reducers**
☐ **Gearmotors**
☐ **Mot-O-Trol**
☐ **Rototrol**
☐ **Life-Line motors**
☐ **D-c motors**
☐ **Adjustable-speed, a-c drives**
☐ **Combination Linestarters**

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Title____

Address________________ City________________ State________

J-90572

APPLICATION ENGINEERING

The how-to-do-it ability of trained Westinghouse engineers is ready to help solve your plant power problems. Co-operative engineering service demands both an aggressive imagination and broad experience in applying basic principles of electricity and allied equipment. Both of these are part of Westinghouse Engineering Service.

RESEARCH

The scope of Westinghouse research reaches into every industry. Wherever power is used and distributed, this research has played an important role in doing jobs better, faster, cheaper.

Westinghouse research facilities are available at any time to help you use the new production tools and apply scientific knowledge in finding practical solutions to production problems.

TRAINING MATERIAL

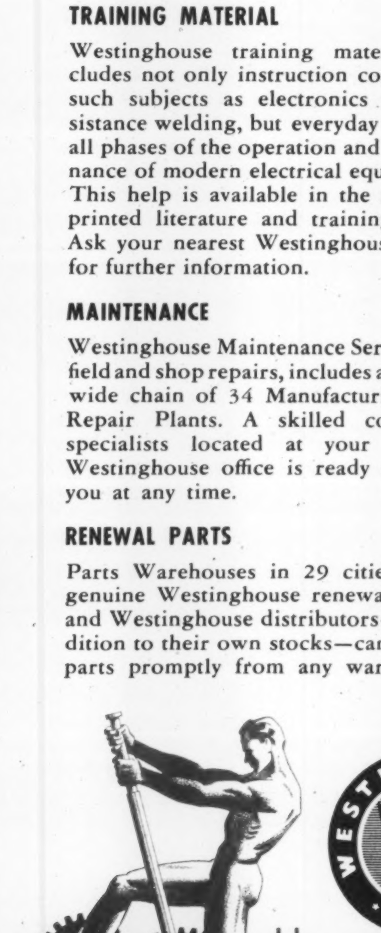
Westinghouse training material includes not only instruction courses in such subjects as electronics and resistance welding, but everyday help in all phases of the operation and maintenance of modern electrical equipment. This help is available in the form of printed literature and training films. Ask your nearest Westinghouse office for further information.

MAINTENANCE

Westinghouse Maintenance Service, for field and shop repairs, includes a nationwide chain of 34 Manufacturing and Repair Plants. A skilled corps of specialists located at your nearby Westinghouse office is ready to help you at any time.

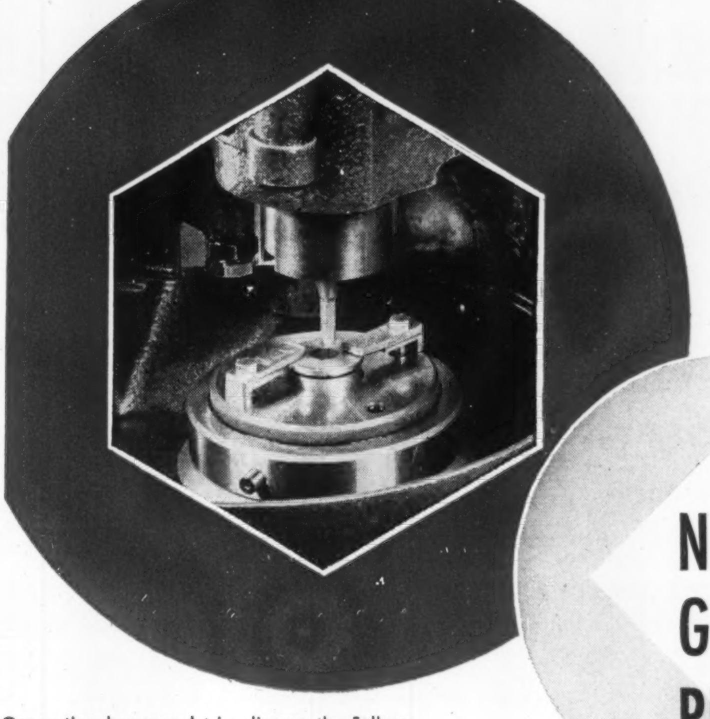
RENEWAL PARTS

Parts Warehouses in 29 cities carry genuine Westinghouse renewal parts, and Westinghouse distributors—in addition to their own stocks—can secure parts promptly from any warehouse.

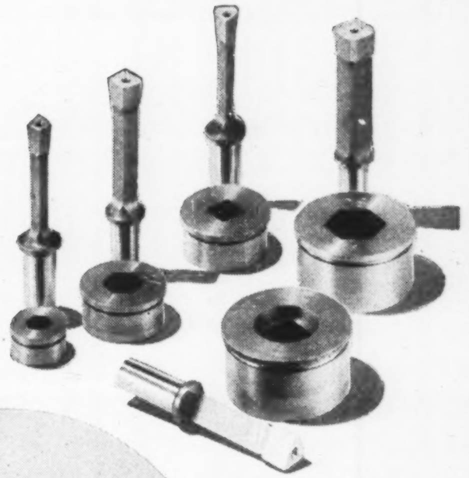


PRODUCTIVE POWER

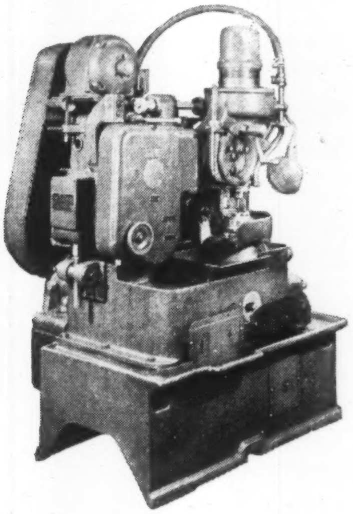
Litho in U. S. A.



Generating hexagonal trim dies on the Fellows Gear Shaper at The Cleveland Cap and Screw Company.



Nut and Bolt Trim Dies Generated to a PRECISE TAPER



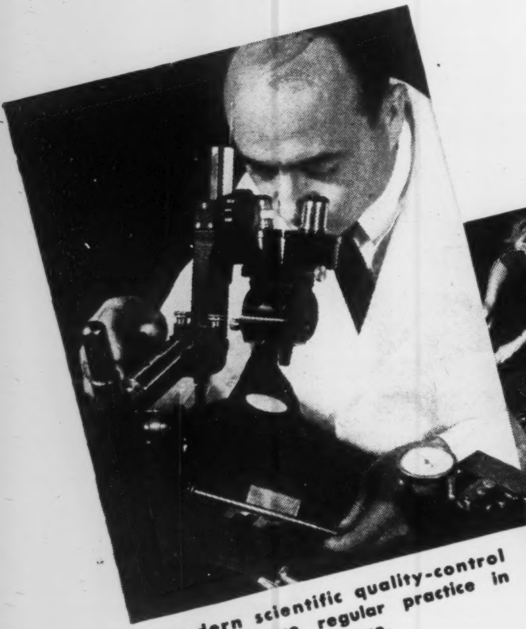
The high-precision ability of the Gear Shaper to generate symmetrical, angular or irregular contours, internal as well as external, carries suggestions to designers in many industries. Hexagon or square trim dies, for instance, can be generated to a controlled taper, as low as ½ degree, with close-tolerance duplicating accuracy.

The versatility of the Gear Shaper on non-gear jobs opens the door to the practical production of many intricate shapes... increases the scope of low cost machining at the designers' command. A reading of our illustrated book, "The Art of Generating with a Reciprocating Tool" will prove of interest to every production-minded design engineer. The Fellows Gear Shaper Company, Head Office and Export Dept., Springfield, Vermont. Branch Offices: 616 Fisher Bldg., Detroit 2... or 640 West Town Office Bldg., Chicago 12, 7706 Empire State Bldg., New York 1.

Fellows

THE FELLOWS METHOD . . . MACHINES AND TOOLS FOR ALL OPERATIONS FROM BLANK TO FINISHED GEAR

When you use FASTENERS you have a wide latitude of choice with the

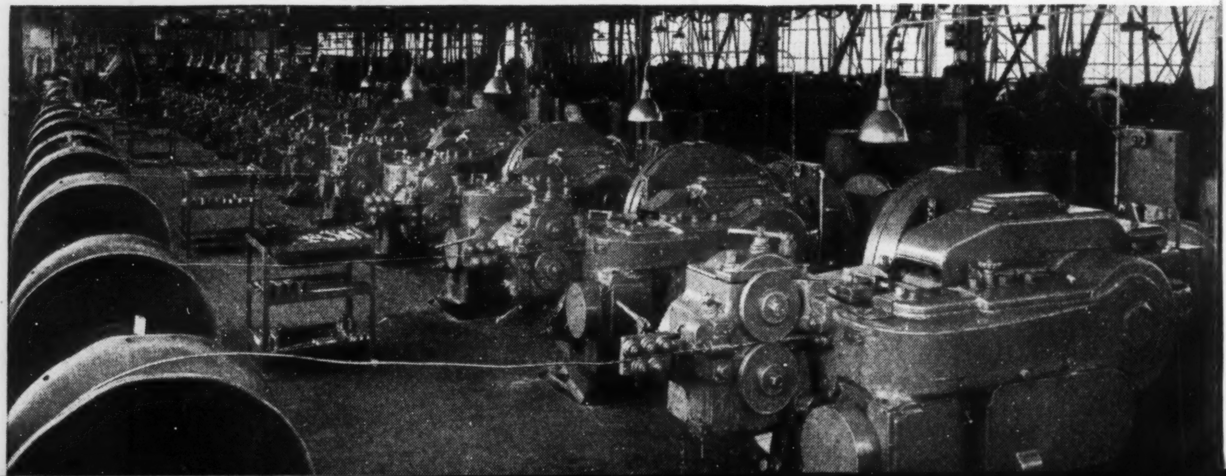


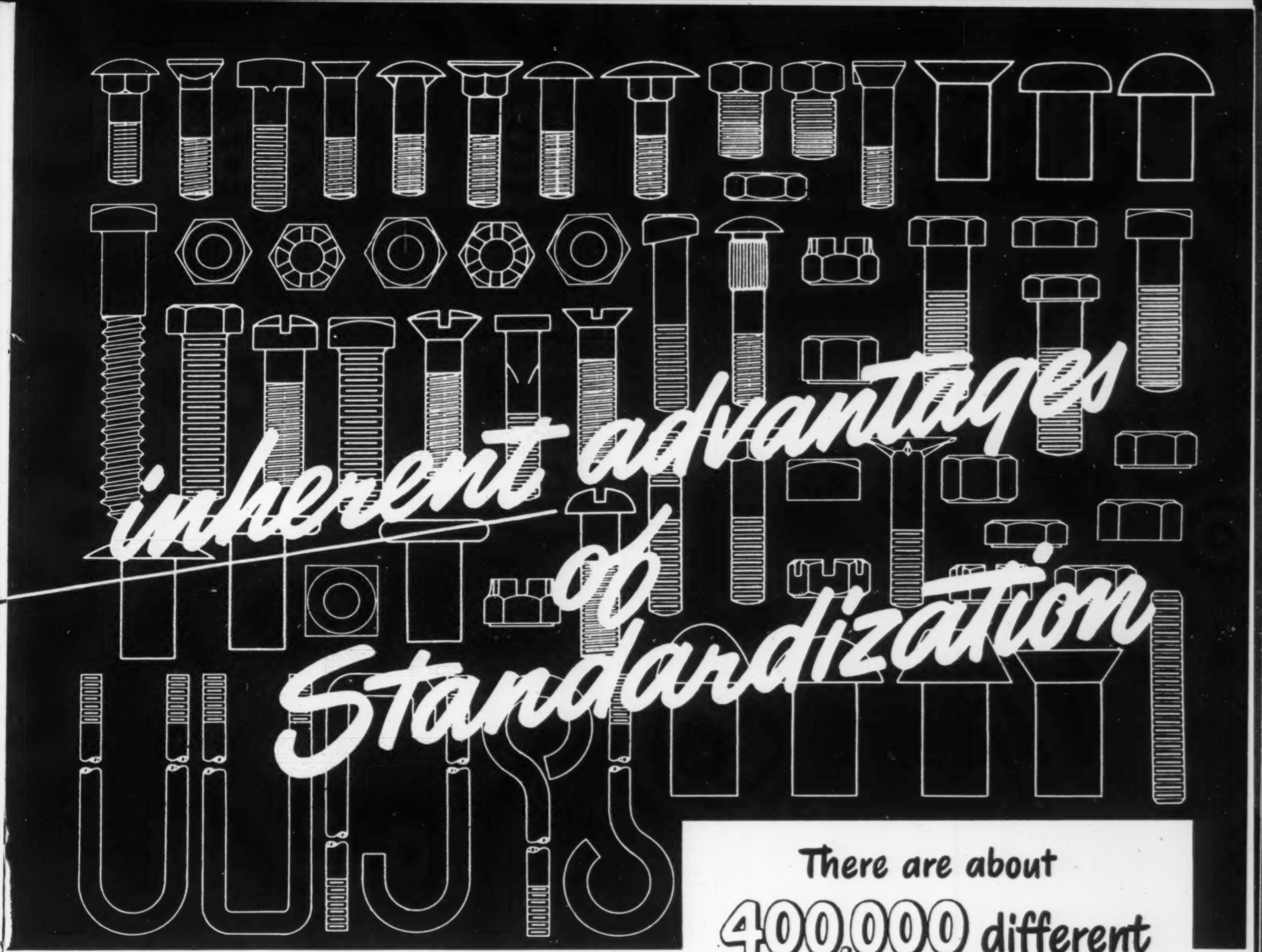
Modern scientific quality-control methods are regular practice in fasteners manufacture.

Constant inspection assures uniform high quality.

Modern Quality-control methods assure close adherence to Industry standards

The low cost and high quality of modern fasteners is due in large part to the use of modern precision machinery.





There are about **400,000** different styles, sizes and types of STANDARD Fasteners

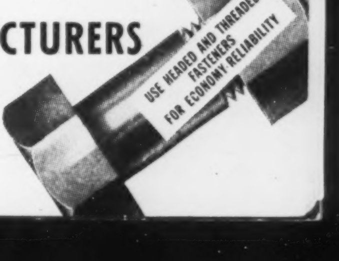
You are well aware of the many advantages of using *standard* component parts in machines, appliances and structures. When you fasten parts together with Fasteners you can usually find standard items that exactly fit your needs, and that can be obtained interchangeably from any one of a dozen manufacturers, with positive assurance of accurate fit. Sometimes a slight alteration in your design will permit the use of a standard fastener, rather than a minor variation from the standard—and you benefit in many ways by the change.

More and more, engineers, designers and manufacturers realize that the dependable, predictable performance of Fasteners means greatest satisfaction and economy. Being mass-produced, they are low in cost; being accurately made from known materials by familiar manufacturing methods, they are reliable.

For dependable and economical joints and connections, use Bolts, Nuts, Screws and Rivets!

AMERICAN INSTITUTE OF BOLT, NUT AND RIVET MANUFACTURERS

1550 Hanna Building · Cleveland 15, Ohio



18-8
Tested and Proved

BY YEARS OF SERVICE AS A RELIABLE CORROSION RESISTANT MATERIAL

WHEN materials come out of the laboratory and into hard, work-a-day, practical use theory stops and experience begins. Gone are the "ifs" and "maybes". A month—a year—ten years, and the final answer is written on their real value. Written not in essays and monographs but in the cold dollars and cents of operating costs and product reliability.

Of all the "stainless" materials none have a finer record under the scrutiny of time than the "18 and 8" alloys. Castings made from this material in our foundry twenty years ago are still rendering reliable service today. That is why we *know* that castings which we will pour tomorrow in our alloy shop will be serving you just as well twenty years from now.

The specifications of one of the Circle Ⓛ family of "18 and 8" Stainless Alloys are given at left. For complete information on these tested and proved corrosion resistant materials, write to us.

LEBANON CIRCLE Ⓛ 22

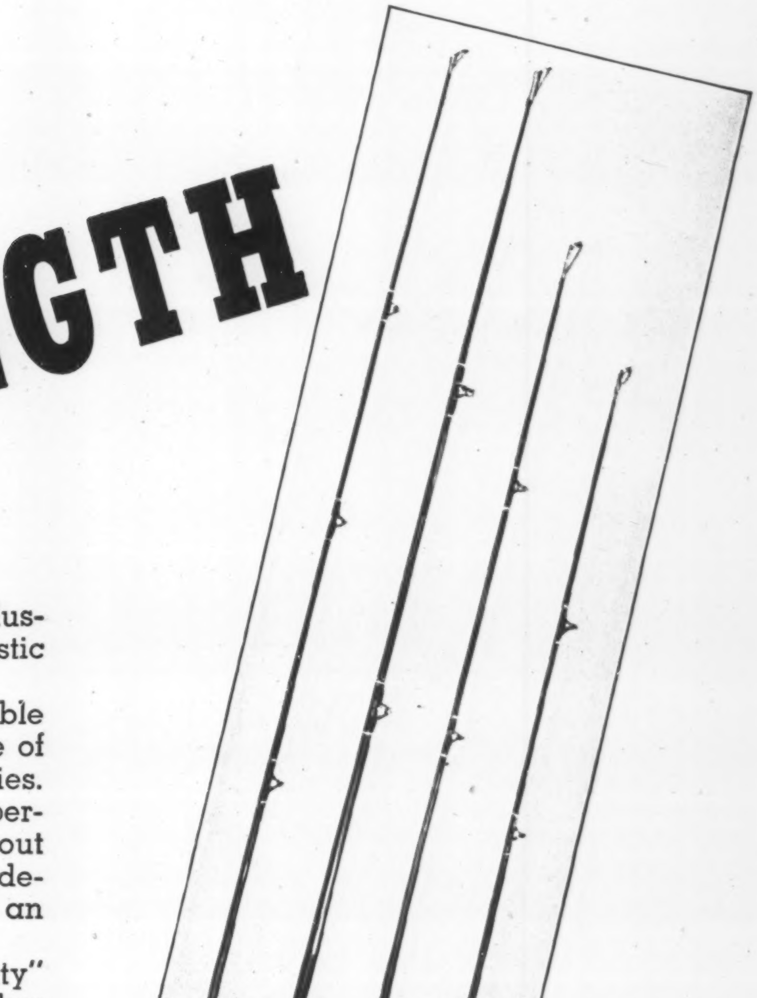
NOMINAL ANALYSIS	
Carbon Max.	0.07
Silicon	1.25
Manganese	0.75
Chromium	19.50
Nickel	9.00
NOMINAL PHYSICAL PROPERTIES	
Tensile Strength	75,000
Yield Point	36,000
Elongation in 2"—%	50
Brinell Hardness	135

LEBANON STEEL FOUNDRY • LEBANON, PA.
"In The Lebanon Valley"
ORIGINAL AMERICAN LICENSEE GEORGE FISCHER (SWISS CHAMOTTE) METHOD

Lebanon CIRCLE Ⓛ ALLOY AND STEEL Castings

Wichita City Library

STRENGTH



THE use of Formica for fishing rods illustrates another valuable characteristic of Formica—flexible strength.

That is just one a number of valuable qualities that has opened a broad use of the material in the mechanical industries.

It is a marvelous bearing material, operating under the heaviest loads without scoring or warping from the heat developed—a quality that has made it an ideal material for ways on planers.

Formica has natural "wetting quality" which makes it easy to lubricate either with oil or water.

It is chemically inert and can be used for such things as plating barrels and rayon equipment where the solutions involved rapidly destroy other materials. It can be molded with electrical conductors incorporated into the sheet.

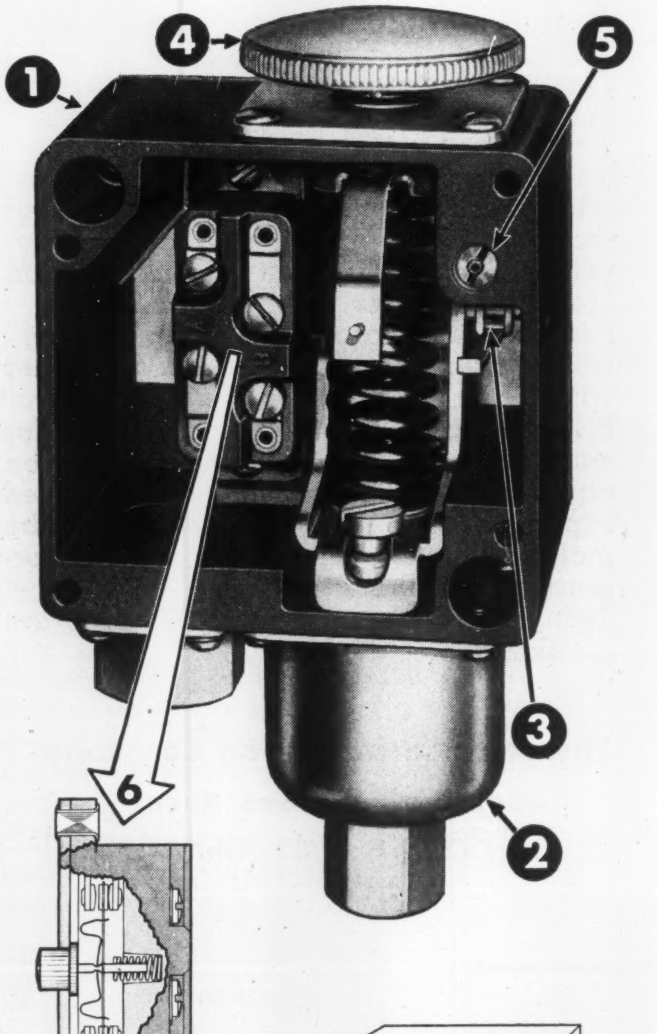
Test figures on all Formica grades are available.

The Formica Insulation Company
4648 Spring Grove Avenue
Cincinnati 32, Ohio

FORMICA
TRADE MARK REG. U.S. PAT. OFF.

NEW Pressure Switch

These Construction Features Make It a Better Pressure Switch for Machine Tool Applications:



① **ENCLOSURE:** Gasketed, die cast construction is oil, coolant and moisture tight. Recessed mounting holes, sealed off by cover gasket, provide an attractive appearance unmarred by projecting mounting lugs. Cover is chained to box and has self-retaining screws. Conduit hub is detachable for ease in installation.

② **MECHANISM:** Seamless metal bellows (*illustrated*) of heavy wall construction are used for pressures ranging from 100 to 1000 pounds per square inch. Hardened parts and short travel characteristic of contact operating mechanism insure unusually long mechanical life under severe service conditions.

③ **INDICATOR:** Lever motion permits easy observation of switch action through window in cover, to assist in proper setting.

④ **RANGE:** Settings, externally adjustable by screw driver or an accessory metal knob, are directly indicated by pointer reading on scale attached to enclosure cover.

⑤ **DIFFERENTIAL:** Difference between "cut-in" and "cut-out" pressures can easily be changed by a set screw adjustment readily accessible with the switch cover removed.

⑥ **CONTACTS:** Heavy duty snap action switch mechanism of self-contained type has separated normally open and normally closed circuits permitting either direct or reverse action by choice of connection. Contacts are double-break, silver. Binder head terminal screws, located immediately adjacent to conduit entrance, accommodate 14 gauge wire. Melamine case is non-carbon-tracking. Entire unit is readily removed for inspection or replacement.

CONTACT RATINGS

	A. C. Voltage				D. C. Voltage*		
Electric Ratings	110	220	440	550	115	230	550
Normal Amperes	15	10	6	5	.5	.25	.05
Inrush Amperes	40	20	10	8	..	..	..

*Single Throw

Designed for Machine Tool Service

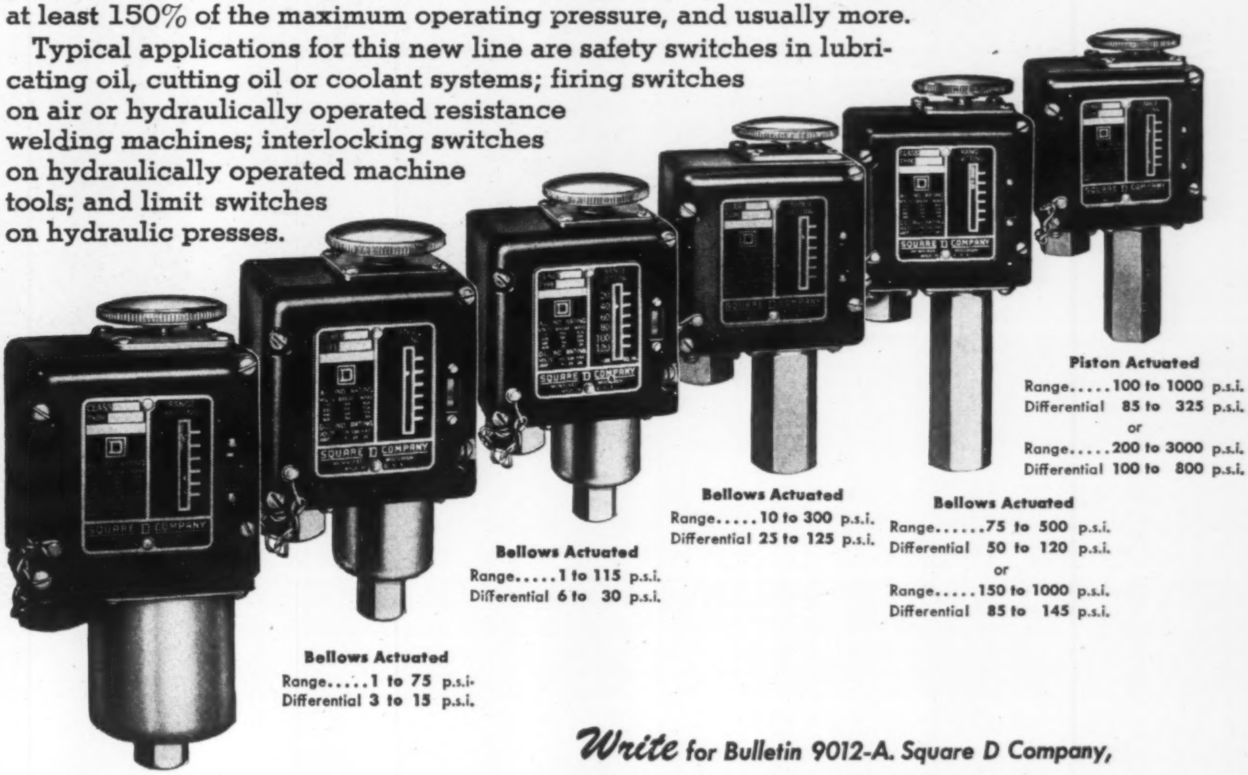
PART OF THE PARADE OF NEW DESIGNS

COVERS ENTIRE RANGE OF MACHINE TOOL PRESSURES

Nine variations of the basic pressure switch are available to suit particular conditions of application. Yet designs are such that any two or three versions of the basic device will serve most machine builders' requirements.

Bellows type actuators are employed on seven variations covering pressures ranging from 1.0 to 1000 p.s.i. with differentials varying from 1/2 to 145 p.s.i. Piston type actuators employed on two variations cover pressures ranging from 100 to 3000 p.s.i. with differentials varying from 85 to 800 p.s.i. All switches are capable of withstanding surge pressures amounting to at least 150% of the maximum operating pressure, and usually more.

Typical applications for this new line are safety switches in lubricating oil, cutting oil or coolant systems; firing switches on air or hydraulically operated resistance welding machines; interlocking switches on hydraulically operated machine tools; and limit switches on hydraulic presses.



Bellows Actuated
Range..... 1 to 10 p.s.i.
Differential ½ to 5 p.s.i.
or
Range......1 to 20 p.s.i.
Differential 1 to 6 p.s.i.

Bellows Actuated
Range.....1 to 75 p.s.i.
Differential 3 to 15 p.s.i.

Bellows Actuated
Range.....1 to 115 p.s.i.
Differential 6 to 30 p.s.i.

Bellows Actuated
Range.....10 to 300 p.s.i.
Differential 25 to 125 p.s.i.

Bellows Actuated
Range......75 to 500 p.s.i.
Differential 50 to 120 p.s.i.
or
Range.....150 to 1000 p.s.i.
Differential 85 to 145 p.s.i.

Piston Actuated
Range.....100 to 1000 p.s.i.
Differential 85 to 325 p.s.i.
or
Range.....200 to 3000 p.s.i.
Differential 100 to 800 p.s.i.

Write for Bulletin 9012-A. Square D Company,
4041 N. Richards Street, Milwaukee 12, Wisconsin

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90% OF ALL V-BELT DRIVE PROBLEMS SOLVED ECONOMICALLY WITH TEXROPE

Pre-Engineered Drives

This New Manual Lists them for Quick Reference

You find number, size and length of belts, diameters of sheaves, power, speed, center distances in one place.

Edge index and classified index make this manual, fast, easy to use. It's a complete V-belt drive reference work.

Complete V-belt drive engineering data tables are included in manual, for figuring special drives.

ALLIS-CHALMERS MANUFACTURING COMPANY, MILWAUKEE, WIS
TEXSTEEL OR TEXDRIVE SHEAVES
Stock Texrope Drives
3 HP — 1150 RPM MOTOR
3 HP

USING STOCK BELTS AND SHEAVES, Texrope engineers have selected the *best* drive for each requirement . . . the drive most economical in first cost and in maintenance.

Only Allis-Chalmers offers you this complete Pre-Engineered drive manual. It is the product of 23 years of industrial V-belt drive experience, the finest engineering talent in the business.

Here is a book that will save you time and money in the purchase of V-belt drive equipment. Copies have been sent to many Texrope users and dealers. If you don't have a copy yet, write for Texbook No. 20P40. ALLIS-CHALMERS, MILWAUKEE 1, WIS.

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TEXROPE ..Greatest Name in V-Belt Drives

"Super 7" V-BELTS
Five Types — Sizes to suit every power transmission job.

Texsteel, Texdrive, "Magic-Grip"
— sheaves in a full range of sizes, grooves.

"Vari-Pitch" SHEAVES
Exact variations in speed, stationery or motion control.

SPEED CHANGERS
Speed variations up to 375% at the turn of a crank.

ENGINEERING
Finest V-Belt engineering talent in the world—at your call.

TEXROPE "Super 7" V-Belts result from the cooperative research of two great companies—Allis-Chalmers and B. F. Goodrich. They are sold only by A-C.

Texrope, Super-7, Texsteel, Texdrive, Magic-Grip and Vari-Pitch are Allis-Chalmers Trademarks

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One of the Big 3 in Electric Power Equipment — Biggest of All in Range of Industrial Products

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90% OF ALL V-BELT DRIVE PROBLEMS SOLVED ECONOMICALLY WITH TEXROPE

Pre-Engineered Drives

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Stock Texrope Drives
Texsteel or Texdrive Sheaves
3 HP — 1150 RPM MOTOR
3 HP

USING STOCK BELTS AND SHEAVES, Texrope engineers have selected the *best* drive for each requirement . . . the drive most economical in first cost and in maintenance.

Only Allis-Chalmers offers you this complete Pre-Engineered drive manual. It is the product of 23 years of industrial V-belt drive experience, the finest engineering talent in the business.

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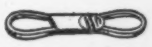
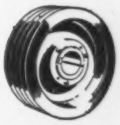
TEXROPE ..Greatest Name in V-Belt Drives

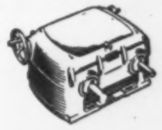


"Super 7" V-BELTS
Five Types — Sizes to suit every power transmission job.



Texsteel, Texdrive, "Magic-Grip"
— sheaves in a full range of sizes, grooves.

"Vari-Pitch" SHEAVES
Exact variations in speed, stationery or motion control.



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Speed variations up to 375% at the turn of a crank.

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A CENTURY OF SERVICE
to Industry
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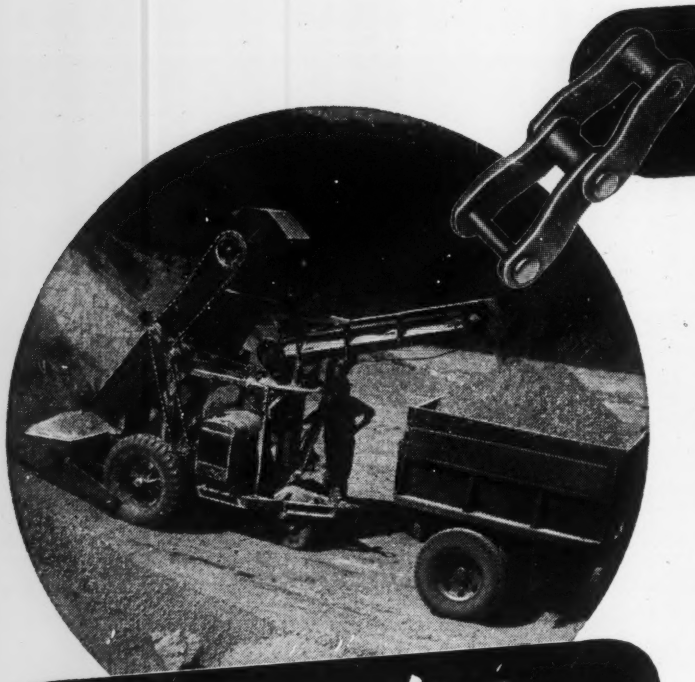
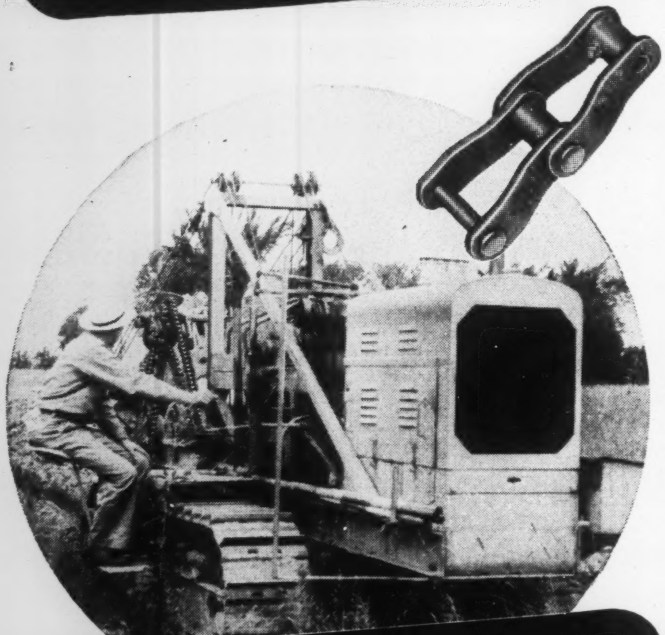


For Loaders

Specify REX Chabelco!



For Ditchers

Rex Chabelco Steel Chain is extra tough . . . *extra* rugged for the roughest type of drive and conveyor service. It's built to give you the added strength you want in your designs . . . to assure the dependable, economical service that adds to product salability.

Each part of Rex Chabelco Chain is precision built to exacting specifications. It combines relative light weight with high strength. Hardened wearing surfaces assure unusual lasting qualities under the most severe service conditions.

Rex Chabelco Drive Chains are used where greater strength, higher speed and long life at high speeds are required, such as for drill-

REX CHAIN BELTS

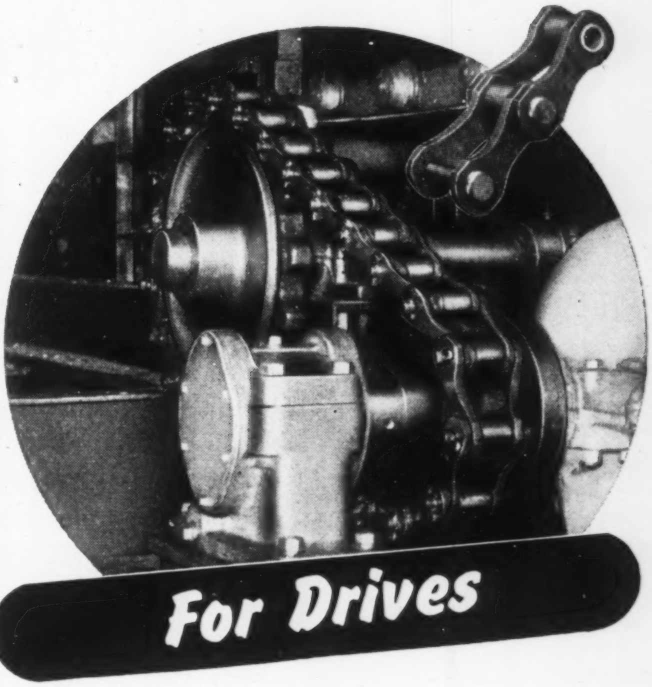
a chain with EXTRA Strength..

For Shovels

ing rigs, construction equipment, heavy conveyor drives, etc.

Rex Chabelco Conveyor Chains are made in both offset side bar and straight side bar types and are used in conveyors where loads are heavy, centers long and service severe. Typical applications are in ovens, assembly conveyors, elevators, bottle washers and pasteurizing machines, pipe mills, steel mills, and many others. Standard attachments are available to answer virtually all conveying needs.

For all the facts and for application assistance, see your Rex Man or write direct to Chain Belt Company, 1643 West Bruce Street, Milwaukee 4, Wisconsin.



For Drives

CHAIN BELT COMPANY
of Milwaukee . . . . .

FREE LENGTH
SIZE OF MATERIAL
PITCH OR LEAD
GROUND SECTION

Will specifications alone give you the best spring?

Sometimes, yes . . . but there are times when strict adherence to specifications may present manufacturing difficulties to the springmaker whose cost may reach unnecessary proportions.

Your spring specifications are thoroughly analyzed by Wallace Barnes engineers — not only for suitability of material, dimensional and load tolerances — but also for the best method of production. If there are advantages to be gained by a change in design or material and still give required results, you are advised.

This is just one of many safeguards your order receives when it bears the destination "Wallace Barnes."

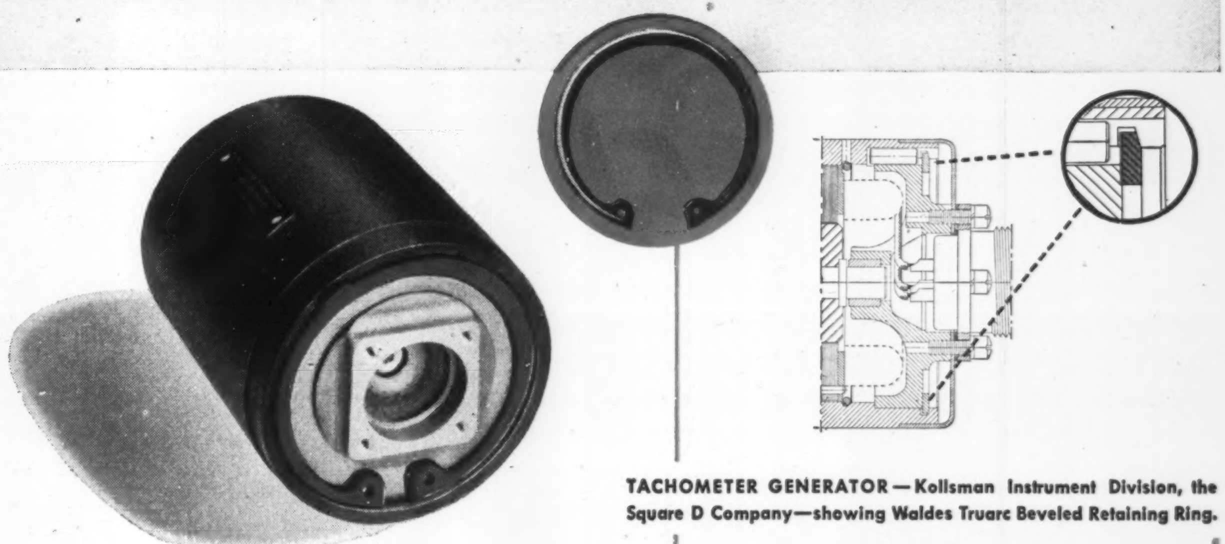
Wallace Barnes SPRINGS

SMALL STAMPINGS • WIRE FORMS • HAIRSPRINGS • COLD ROLLED SPRING STEEL

WALLACE BARNES COMPANY
BRISTOL, CONN.

DIVISION OF THE ASSOCIATED SPRING CORP.
AND IN CANADA, THE WALLACE BARNES CO., LTD., HAMILTON, ONTARIO

Truarc Beveled Ring takes up end-play, eliminates shims, saves 20 minutes' assembly time



TACHOMETER GENERATOR—Kollsman Instrument Division, the Square D Company—showing Waldes Truarc Beveled Retaining Ring.

When installed in a groove with a corresponding bevel, the tapered edge of the Beveled ring acts like a wedge and rigidly bridges end-play. End-play can also be taken up resiliently by another type Truarc ring—the Bowed.

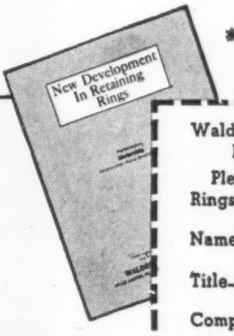
Wherever you use machined shoulders, nuts, bolts, snap rings, cotter pins—there's a Truarc ring that does a better job of holding parts together. All Truarc rings are precision engineered, easy to assemble and dis-assemble, always circular to give a never-failing grip. They can be used over and over again.

See what can be done for your product: send a drawing to Waldes Truarc Technical Service Engineers for individual attention without obligation.

One Waldes Truarc Beveled Retaining Ring gives Five big advantages:

- **Secures the cover with its connecting parts in the housing against strong pressure, heavy vibration**
- **Absorbs accumulated tolerances up to .010 (ring diameter is 1.9375)**
- **Eliminates shims, saves material and weight**
- **Saves 20 minutes' assembly time**
- **Simplifies field maintenance by facilitating quick dis-assembly, re-assembly**

Mail this coupon today for your copy of "New Development in Retaining Rings"



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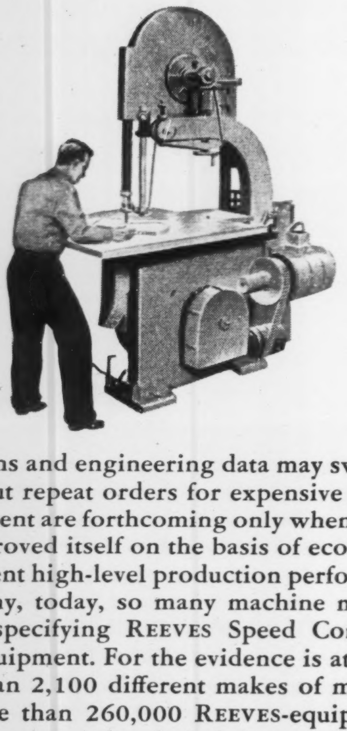
raise production levels of the machines you build

THE REEVES WAY



Specifications and engineering data may swing the first sale. But repeat orders for expensive production equipment are forthcoming only when the machine has proved itself on the basis of economical and consistent high-level production performance.

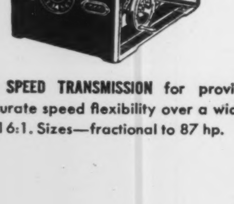
That's why, today, so many machine manufacturers are specifying REEVES Speed Control as standard equipment. For the evidence is at hand—on more than 2,100 different makes of machines and in more than 260,000 REEVES-equipped installations—to prove that the infinite, stepless speed adjustability provided by REEVES Variable Speed Drives is a vital factor in assuring increased production of a higher, more uniform quality—at lower cost!

Applied to the machines you build, REEVES Speed Control will permit instant, accurate speed changes without stops. It will allow each operator to select the speed best suited to his own particular skill . . . or to the requirements of the operation he is performing . . . or to the characteristics of the material being processed. In other words, REEVES *will provide the right speed under every changing condition.*

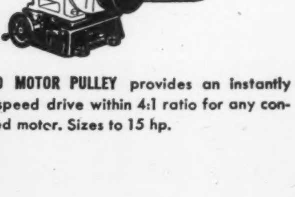
REEVES offers you a complete line of soundly designed, ruggedly built and easy-to-maintain speed control units. There is a wide selection of designs, sizes, speed ratios and controls, the latter including push button and completely automatic. Also available are internal operating parts of REEVES units for incorporation within the framework of your machines. A REEVES speed control specialist with a sound background of design and application experience will be glad to work with you in choosing the REEVES units best suited to your standard equipment needs. Feel free to call upon his services and also to write us for the complete information on REEVES Speed Control contained in our new 114-page catalog, H-450A.

REEVES PULLEY COMPANY • COLUMBUS; INDIANA

THE 3 BASIC REEVES SPEED CONTROL UNITS



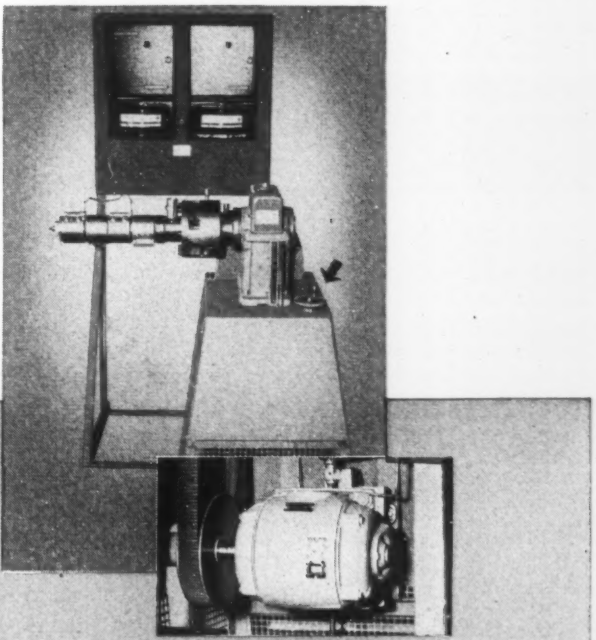
VARIABLE SPEED TRANSMISSION for providing infinite, accurate speed flexibility over a wide range —2:1 to 16:1. Sizes—fractional to 87 hp.



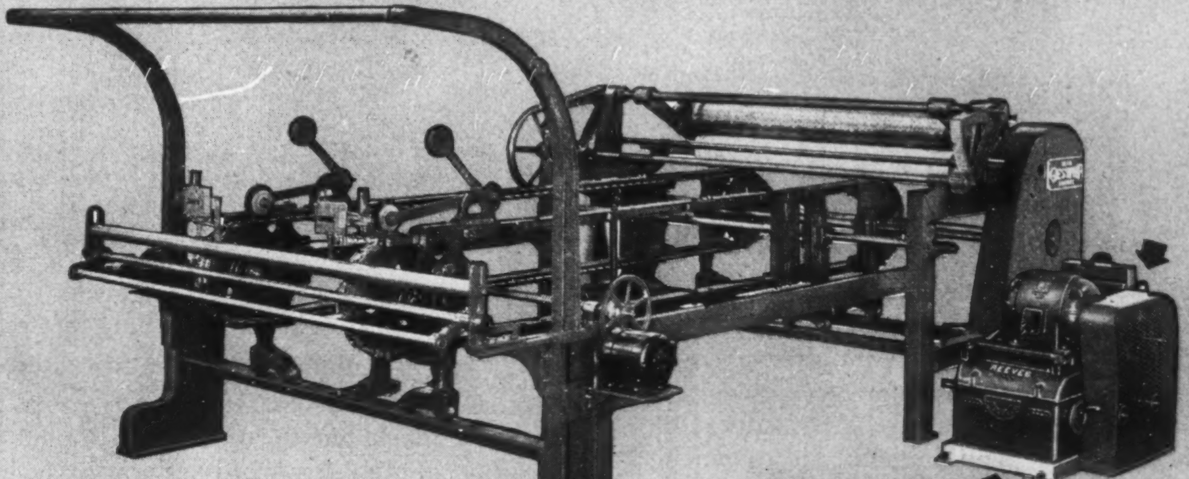
VARI-SPEED MOTOR PULLEY provides an instantly variable speed drive within 4:1 ratio for any constant speed motor. Sizes to 15 hp.

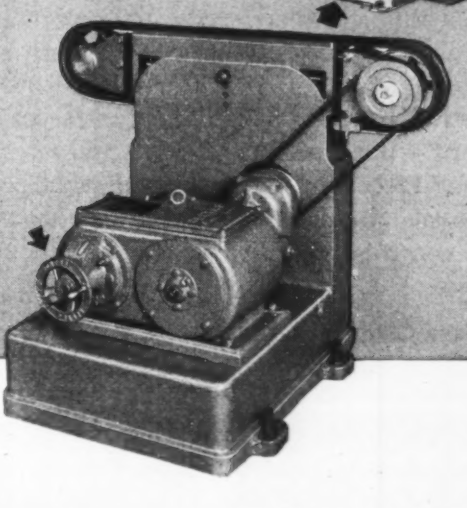
MOTODRIVE combines motor, speed varying mechanism and reduction gears in single compact unit. Speed variations 2:1 to 6:1 inclusive. Sizes to 15 hp.

Right: In designing this machine for the extrusion of high-temperature thermo-plastics such as nylon, Hartig Engine & Machine Co., Hillside, N. J., was faced with a speed control problem. The problem was to provide infinitely variable speed for the stock screw in order to compensate for the slightest change in each batch and for size of die used. The solution: REEVES Vari-Speed Motor Pulley (inset) was incorporated as standard equipment to deliver any desired screw speed within a 4:1 ratio.



Below: Two REEVES Variable Speed Transmissions are furnished as standard equipment on this tenter frame, manufactured by David Gessner Company, Worcester, Massachusetts. One REEVES unit provides infinitely variable cloth speeds, from 14 to 56 yards per minute; the other regulates "pick-off" prior to batching. Thus the machine can be adjusted instantly for materials of varying weights, moisture content and texture.

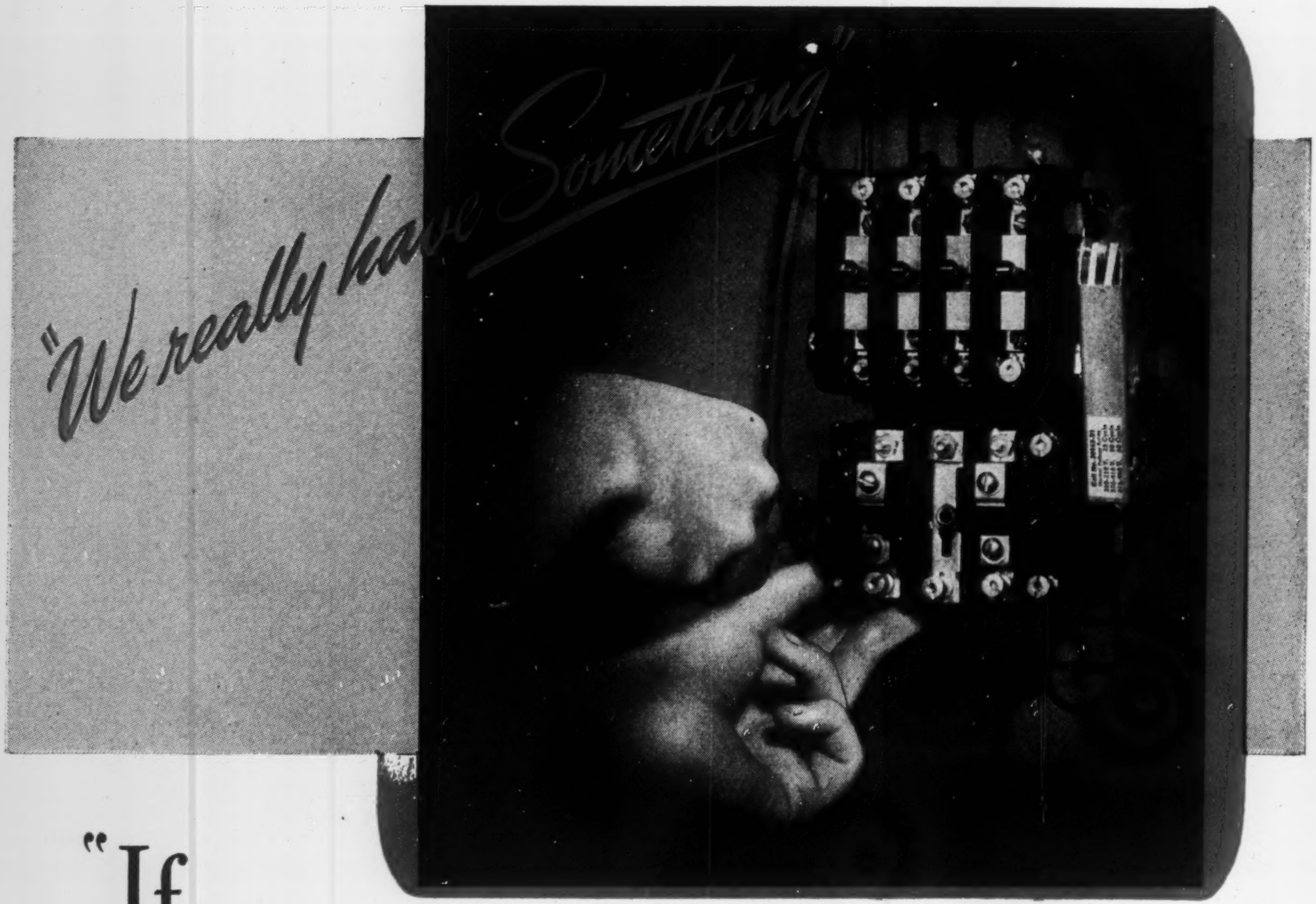




Right: For efficient transfer of extruded electrodes from hydraulic extrusion press to brushing machine, this Transfer Conveyor has as standard equipment a REEVES Motodrive. A turn of the convenient handwheel produces any desired conveyor speed from 730 to 126 fpm., or transfers 630 to 126 coated electrodes 5/32″ in diameter by 14″ long. To insure maximum production and a minimum number of workers, REEVES Variable Speed Drives are essential on this Transfer Conveyor and on all welding rod processing machinery. This conveyor is built by Moslo Machinery Company, Cleveland, Ohio.

Recognized Leader in the Specialized
Field of Speed Control Engineering

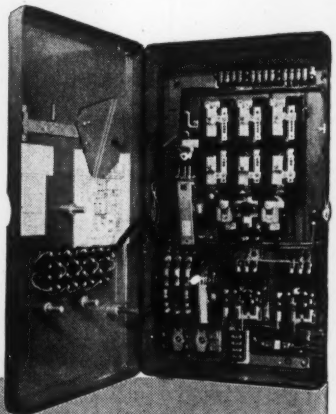
Accurate Variable
REEVES Speed Control
Gives the Right Speed for Every Job!



"If you could come with me to the special assembly division at Plainville, you'd see what I mean. The day we took these pictures, for example, there was a multi-motor controller for a famous machine tool manufacturer, individual plug-in type control center units for a large oil refinery, the complicated fully automatic 'electric brain' for a paper making machine — all being manufactured on a standard production basis — *specials* in every sense of the word — but made from tried and proved Trumbull Electric basic components. Such basic components mean to you, as the customer, special controls with *standard* Trumbull performance.

"Standard design elements in the tremendously varied Trumbull production range make it possible for our customers' design engineers to specify special controls without running into a stone wall of excessive *special costs.*

"Of course, we of Trumbull can only try to give you a quick picture of a mighty good proposition in these few words. If you have a problem that indicates modern electrical control, it will be well worth your while to write now or come to our Plant and see for yourself. Trumbull engineers are good people to talk to — and work with."



TRUMBULL T ELECTRIC

MOTOR CONTROL

THE TRUMBULL ELECTRIC MANUFACTURING CO.
PLAINVILLE, CONNECTICUT
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FREE CUTTING BRASS ROD
FOR QUICK, ECONOMICAL MACHINING

1—Special flange fitting
2—Flexible tube adapter
3—½" high-pressure fitting
4—Tapered hose connection
5—Flared-type fitting
6—Bushing for pressure tube fitting
7—Inverted S.A.E. swivel union
8—Automotive brake cylinder
9—Faucet handle
10—Flared-type fitting
11—Hot water cut-off valve
12—Oil tank cap part
13—½" I.P.S. male fitting
14—Valve stem regulator
15—Welding hose connection
16—Automotive air brake part
17—Water valve stem pack nut
18 & 19—Lamp top ornaments
20—Carbureter valve
21—Welding hose connection
22—Oil feeder valve
23—Valve stem
24—Pack nut
25—Inverted S.A.E. swivel union
26—Male swivel detachable union
27—Flared-type fitting
28—Detachable ring-type hose fitting
29—Compression fitting assembly
30—Oil feeder adjusting valve
31—7/16" female compression union
32—Fuse part
33—S.A.E. long nut
34—Orifice spud
35—Worm gear
36—Threaded sleeve-type union
37—Toilet tank spud
38—Acorn nuts for finish trim
39—Hex nuts

Available NOW!

REVERE FREE CUTTING BRASS ROD

A Versatile Metal. Though in many cases it is machining quality that is the primary reason for the specification of Revere Free Cutting Brass, this versatile metal has other important qualities that are worth remembering. It is strong, having a tensile strength of 49,000 pounds or more per square inch. Hence it can take relatively heavy loads. Threads and collars can be depended upon to stand up under stress. Another important factor is its favorable coefficient of friction with cast iron and steel in bearings. This brass is also highly resistant to corrosion, being unaffected by, and free from contaminating effects upon, a wide variety of gases and liquids, resulting in its use in valves, fittings, unions, nozzles and similar parts.

Lead Content. Revere Free Cutting Brass Rod contains about 3% lead. This is not dissolved but is thoroughly distributed throughout the metal in the form of finely-divided particles. The lead reduces friction by causing the chips to break off short, so that they are in only momentary contact with the cutting edge of the tool. This lessens the amount of heat generated. Life of the tool is correspondingly extended, and long runs without regrinding are usual.

Machining Speeds. Surface speeds as high as 700 feet per minute are possible. Rough cuts as deep as 0.020″ can be taken. Such speeds and cuts materially reduce production time over other materials having less outstanding machining characteristics.

Finish. With proper tooling, parts made of Revere Free Cutting Brass Rod come from the machine with a brilliant, smooth, highly-polished appearance, due to the practically flawless surface. Any tolerance within the capability of the machine and operator may be easily obtained. Threads are sharp and clean down to their roots.

No Burrs. This metal may be cut- and roll-threaded, drilled and tapped, milled, broached, and sawed with no appreciable burrs.

Temper. In the majority of cases, Revere Free Cutting Brass Rod is supplied hard drawn. This hardness facilitates chip breakage, while the high strength resulting from drawing assures strong threads. However, if desired for special purposes, Revere can supply soft Free Cutting Brass Rod.

High Standards. Revere Free Cutting Brass Rod is drawn to close tolerances on dimensions and straightness, and is stress-relieved after drawing. The metallurgical and physical characteristics of the metal are under constant laboratory check. It is therefore especially suitable for automatic screw machines, which require stock having high uniformity in quality and dimensions.

Additional Advantages. The smooth surfaces produced by machining Revere Free Cutting Brass Rod are ideal for plating. The metal is easily soldered, can be welded if desired, and it is of course non-rusting and corrosion-resistant. Even at a slightly higher cost over other materials, this brass often is more economical for screw machine production, due to the speed with which the various operations may be conducted, and the value of the scrap.

Consult Revere. Because no single metal or alloy is suitable for all requirements, Revere offers many, each having some outstanding virtues and advantages. Selection of the most advantageous Revere Metal for a given process, part, or product may make a big improvement in such important items as cost of manufacture, durability, and even saleability. The Revere Technical Advisory Service will gladly cooperate with you in studying your requirements.

TYPICAL PROPERTIES
REVERE FREE CUTTING BRASS ROD
Alloy No. 240

COMPOSITION
Copper 61.5%
Zinc 35.5
Lead 3.0

TENSILE STRENGTH
Hard* 58,000 pounds per square inch
Soft† 49,000

ELONGATION
% in 2 inches
Hard* 25
Soft† 53

DENSITY
0.307 lbs. per cubic inch

Coefficient of Expansion
.0000114 per °F @ 68°F

ELECTRICAL CONDUCTIVITY
26 (%I.A.C.S. @ 68°F)

THERMAL CONDUCTIVITY
67 Btu. per sq. ft. per ft. per hr. per °F @ 68°F

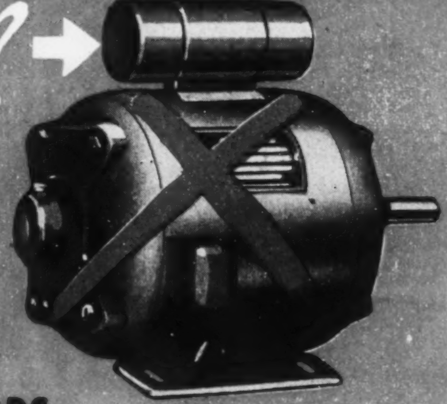
*Hard, Rockwell B78 (app.)
†Soft, Rockwell F68 (app.)

Revere also supplies other types of Free Cutting Brass with desirable qualities for special operations, such as riveting or upsetting, spinning, highly accurate deep drilling.

Revere Metals include: *Copper and Copper Alloys:* Sheet and Plate, Roll and Strip, Rod and Bar, Tube and Pipe, Extruded Shapes, Forgings; *Aluminum Alloys:* Tube, Extruded Shapes, Forgings; *Magnesium Alloys:* Sheet and Plate, Rod and Bar, Tube, Extruded Shapes, Forgings; *Steel:* Electric Welded Steel Tube.

REVERE
COPPER AND BRASS INCORPORATED
Founded by Paul Revere in 1801
230 Park Ave., New York 17, New York
Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; New Bedford, Mass.; Rome, N. Y. — Sales Offices in Principal Cities. Distributors Everywhere.

Why use obsolete Motors?

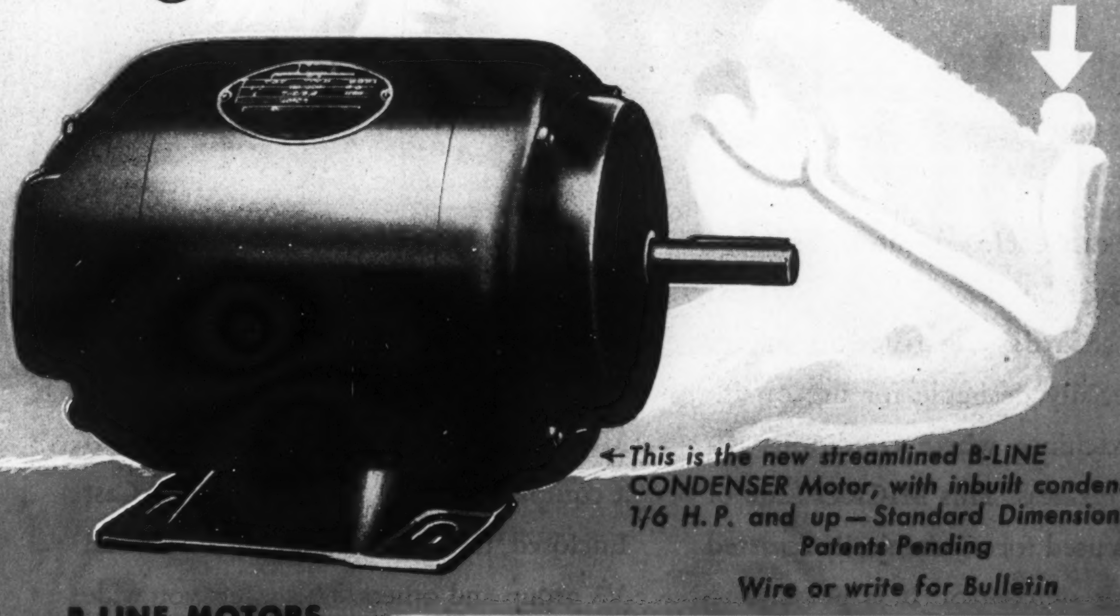


HERE'S JUST AN EXAMPLE OF B-LINE LEADERSHIP IN IMPROVED DESIGN OF CONDENSER TYPE MOTORS

"TRULY LIFE-TIME MOTORS"
B-LINE
Reg Trade Mark

Constantly Improved

THE WART COMES OFF THE HOG'S NOSE



← This is the new streamlined B-LINE CONDENSER Motor, with inbuilt condenser. 1/6 H.P. and up — Standard Dimensions — Patents Pending

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1/6 to 30 HP

B-LINE GEARMOTORS
All Standard and Special Ratios

TOOLMASTER
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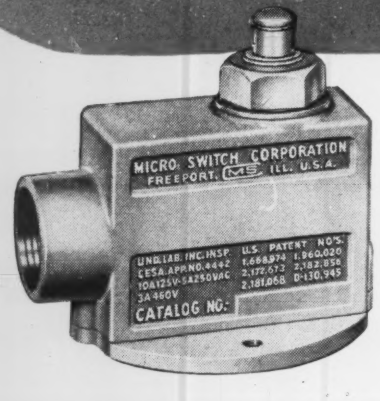
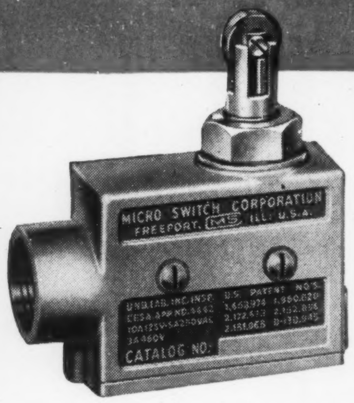
The Die Cast Enclosed Line of MICRO Varying Actuators Meet Most


MICRO SWITCH CORPORATION
FREEPORT, ILL. U.S.A.
CATALOG NO.:

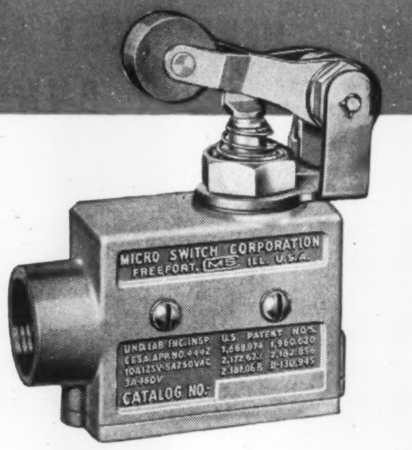
MICRO Precision Switch
BZV-2RQ

"Q" Actuator is well suited for use in applications where actuating motion is in line with plunger motion.


MICRO SWITCH CORPORATION
FREEPORT, ILL. U.S.A.
CATALOG NO.:

MICRO Precision Switch
BZE-2RQ9

The "Q9" Roller Actuator is ideal for use with cams and slides—roller assembly may be turned 90°.


MICRO SWITCH CORPORATION
FREEPORT, ILL. U.S.A.
CATALOG NO.:

MICRO Precision Switch
BZE-2RQ2

The "Q2" Roller Lever Arm Actuator is for use with fast cam and slide actuation.

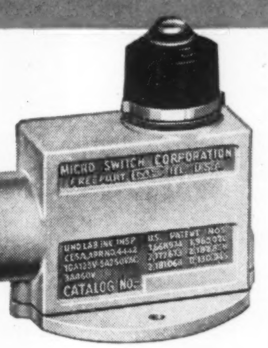
Here Are a Few of the Many Types of Enclosed Switches That Are Available

● The die cast enclosed line of MICRO Precision Switches is available with varied actuators. Sturdy construction makes them especially desirable for use on industrial machines where conditions demand ruggedness. This MICRO Line of switches is used for mechanically actuated safety, limit or control. It is possible to mount them from side or bottom. Roller lever arms are adjustable vertically through an arc of 225 degrees or horizontally through 360 degrees. Plunger type actuators have hardened tip which moves in a brass sleeve for long life.

MICRO Precision Switches are made in a complete line—the Basic, the Die Cast Enclosed, the Explosion Proof, the small V3 group and others. This offers you wide selection to secure the exact switch to meet exacting requirements.

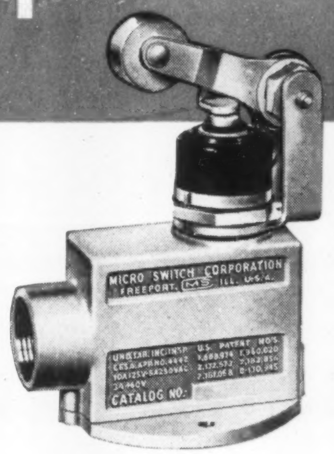
MADE WITH THE *"KNOW-HOW"* BEHIND MILLIONS OF PRECISION SWITCHES

Precision Switches with Equipment Requirements



MICRO Precision Switch BZV-2RN

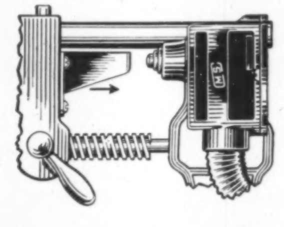
The sealed plunger type actuator is for use where oil, water, dust or abrasives are present.



MICRO Precision Switch BZV-2RN2

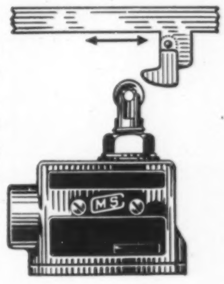
The sealed plunger roller lever arm actuator is for use with fast cams and slides where oil, water, dust or abrasives are present.

Here Are Four Representative Applications



Above illustration shows MICRO die cast switch being used as a limit switch on the carriage of a lathe.

The illustration to the right shows operation of switch only when slide is moving to the left.



The illustration to the right shows actuation by slide. It is also useful where actuation is by fast cams.

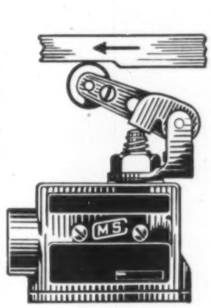
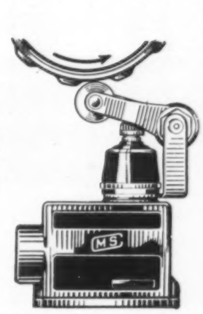
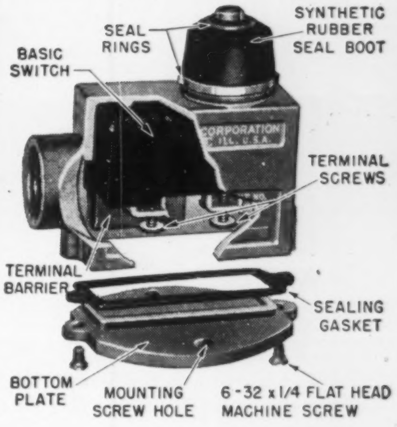


Illustration shows actuation by disc and cam with roller arm and sealed plunger.

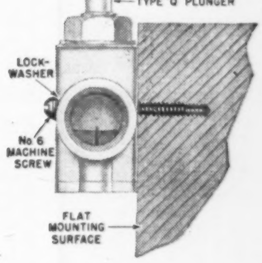


HERE'S THE CONSTRUCTION


SEAL RINGS
SYNTHETIC RUBBER SEAL BOOT
BASIC SWITCH
TERMINAL SCREWS
TERMINAL BARRIER
SEALING GASKET
BOTTOM PLATE
MOUNTING SCREW HOLE
6-32 x 1/4 FLAT HEAD MACHINE SCREW

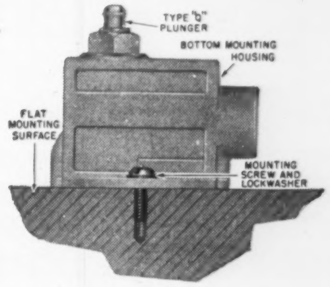
This cut-away view shows arrangement of the basic switch in the die cast housing. Housing shown is bottom mounting design.

AND HERE'S THE WAY THEY ARE MOUNTED


TYPE "Q" PLUNGER
LOCK-WASHER
No 6 MACHINE SCREW
FLAT MOUNTING SURFACE

SIDE MOUNTING

This mounting can be arranged from either side. Lead washers are provided on sealed-type switches.


TYPE "Q" PLUNGER
BOTTOM MOUNTING HOUSING
FLAT MOUNTING SURFACE
MOUNTING SCREW AND LOCKWASHER

BOTTOM MOUNTING

Bottom mounting designs have a flanged bottom plate, ⅛ inch in thickness. Bottom plates are gasketed.

MICRO Precision Switches

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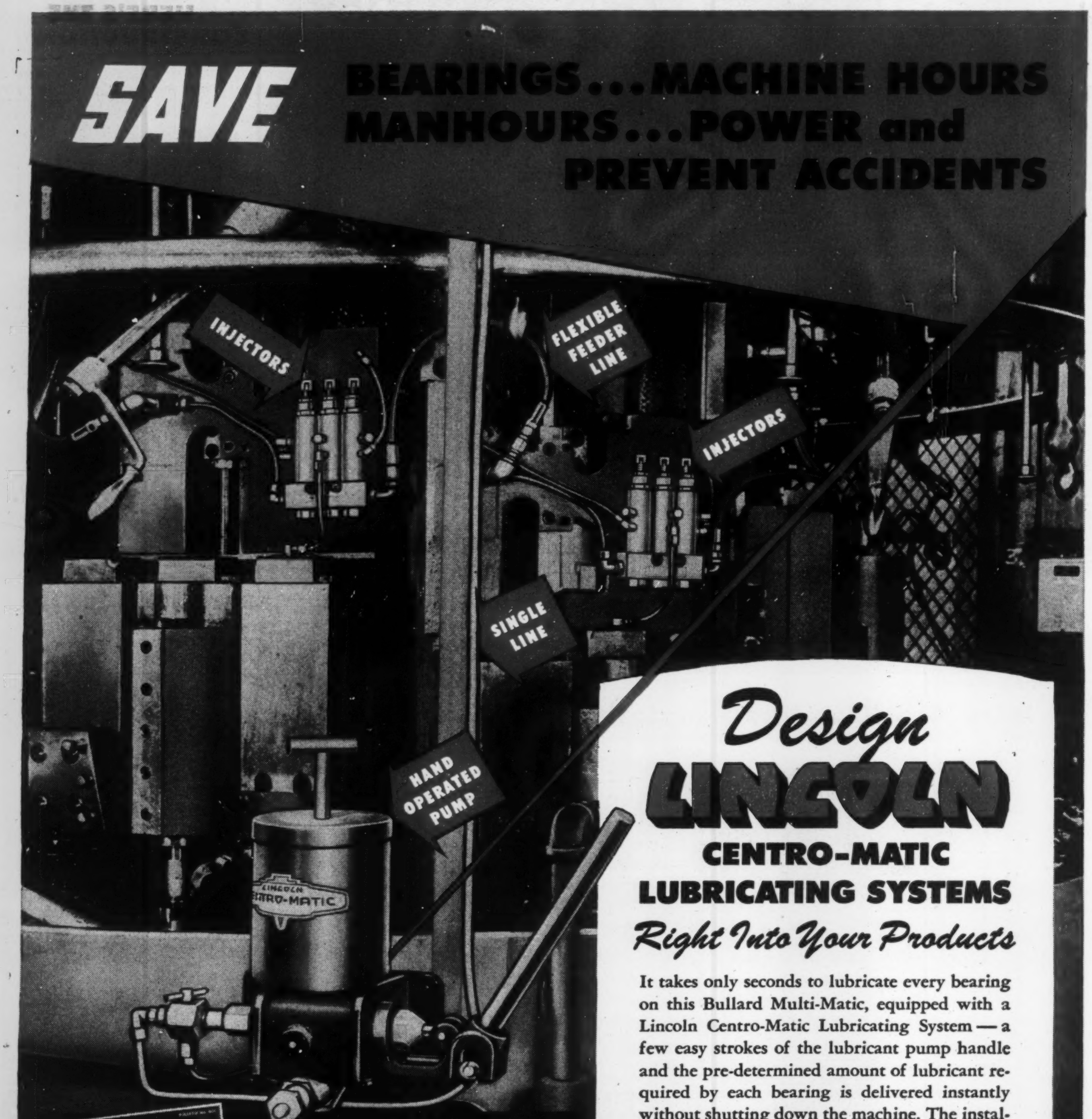
INJECTORS
FLEXIBLE FEEDER LINE
INJECTORS
SINGLE LINE
HAND OPERATED PUMP
LINCOLN CENTRO-MATIC

Design LINCOLN CENTRO-MATIC LUBRICATING SYSTEMS

Right Into Your Products

It takes only seconds to lubricate every bearing on this Bullard Multi-Matic, equipped with a Lincoln Centro-Matic Lubricating System — a few easy strokes of the lubricant pump handle and the pre-determined amount of lubricant required by each bearing is delivered instantly without shutting down the machine. The installation is simple—all that is required is a Centro-Matic Injector for each bearing, arranged singly or in manifold, and connected by a *single lubricant line* to the Centro-Matic Pump.

Enhance the value of the machines you manufacture—Include Lincoln Centro-Matic Systems as standard equipment.

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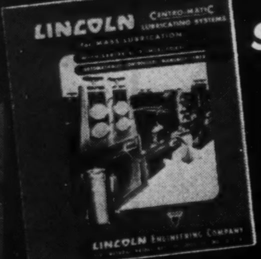
Pioneer Builders of Engineered Lubricating Equipment


LINCOLN
CENTRO-MATIC LUBRICATING SYSTEMS
LINCOLN ENGINEERING COMPANY

Send For This BULLETIN

Bulletin No. 801 gives you complete information on the newest developments in Centralized Lubrication. It illustrates and describes the various types of Centro-Matic injectors and a range of hand and power operated pumps to meet the lubrication requirements of various types of machines and machinery. Every Design Engineer should have a copy. Write us for it, or consult our engineers on your lubrication problem.

Trade Mark LINCOLN and Trade Name CENTRO-MATIC Registered U. S. Pat. Office.

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This Rugged Performer Needs No Pampering!

DELCO
DAYTON·OHIO

Features that mean better performance for the NEW DELCO MOTOR

Totally enclosed; fan-cooled.

Individually taped coils.

Thoroughly insulated windings.

Unit-cast, ball-bearing rotor, dynamically balanced; parts interchangeable end to end.

Double-shell frame with new simplified cooling system.

Extra-large, watertight conduit box, usable in four 90-degree positions.

Extended, accessible mounting feet, cast as a unit with main frame.

From 1½ h.p. through 50 h.p.; NEMA frame sizes, 224 through 505.

The New Delco Motor

The double-shell frame is totally enclosed. The conduit box is oil- and water-tight. Greater simplicity and accessibility, better ventilation and insulation are achieved through new design practices and improved materials.

It's such advanced features as these that keep the great Delco motor performing faultlessly in spite of airborne dirt, dust, sand and scale . . . and that make maintenance procedures so few and so easily performed.

If you want to reduce motor failures and maintenance costs wherever operating conditions are unfavorable, you want to know more about the new Delco motor. Write for complete data.

DELCO MOTORS

DIVISION OF GENERAL MOTORS CORPORATION

Photo courtesy Brown Citrus Fruit Machinery Co.

Juice cups molded by Kirkhill Rubber Co.

A *Squeeze Play* that benefits everyone

FLOODS of vitamin-rich juice are whirled from ripe oranges by this automatic Citrus Juice Extractor.

The squeeze is on the orange halves as they are gripped and firmly pressed against whirling metal cones by cups made from a compound of Geon polyvinyl resin and Hycar American rubber.

Because this composite material is unaffected by fruit oils, acids, moisture, because it is impervious to contamination, because the cups made from it perfectly perform their gripping function despite variation in the size of fruit, important benefits result.

Ripe fruit is fully utilized, waste prevented, a healthful food product is available on your grocer's shelves at modest price, the owners of the machine have substantially reduced the cost of maintenance and operation.

Geon polyvinyl resins and Hycar American rubber are materials for which new cost-saving, problem-solving uses are discovered almost daily. Molded, calendered, cast, or used as impregnants for fibres and fabrics, their versatility may contribute importantly to the product you make and to articles you use daily.

B. F. Goodrich Chemical Company makes no finished products from Geon or from any other raw material. However, we will be glad to work with you on any special problems of application. We are particularly interested in developing new end uses for these materials. For more information please write Department HN-12, *B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio.*

Geon
Polyvinyl Materials
A TRADE MARK OF B. F. GOODRICH CHEMICAL COMPANY

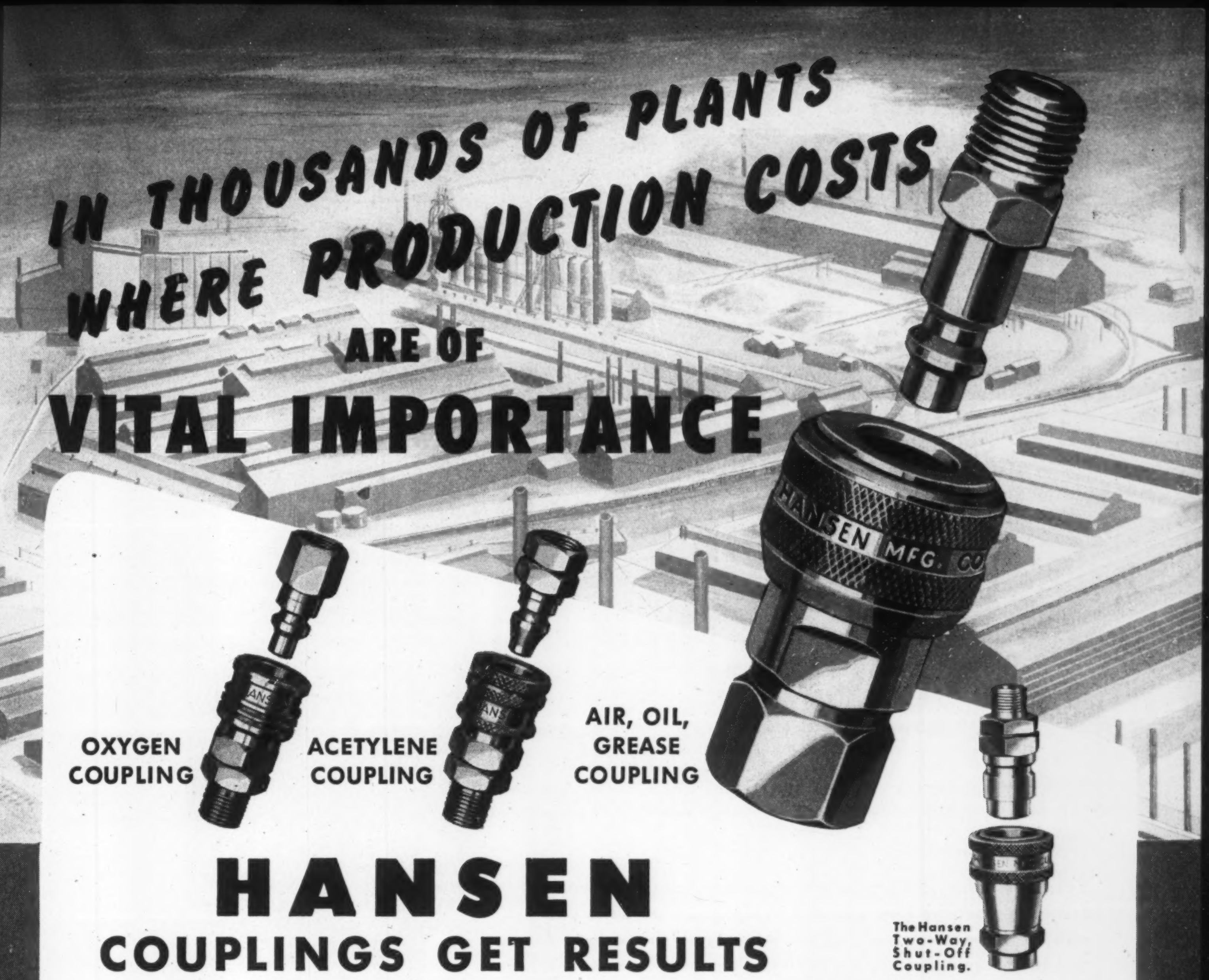
Hycar
Reg. U. S. Pat. Off.
American Rubber

B. F. Goodrich Chemical Company

A DIVISION OF
THE B. F. GOODRICH COMPANY

GEON polyvinyl materials • HYCAR American rubber • KRISTON thermosetting resins • GOOD-RITE chemicals

IN THOUSANDS OF PLANTS WHERE PRODUCTION COSTS ARE OF VITAL IMPORTANCE



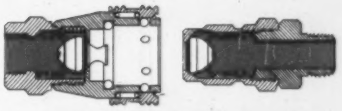
The Hansen Two-Way, Shut-Off Coupling.

HANSEN

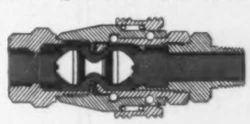
COUPLINGS GET RESULTS

When you use Hansen couplings, connections and change-overs become a matter of seconds — with no hold-up of costly operations. ◆ ◆ ◆ To connect a Hansen coupling on air, oil, or grease lines, you merely push plug into socket—flow is immediate and completely automatic. To disconnect, slide sleeve back with thumb, plug pops out and supply line is effectively sealed with no leaks or losses. ◆ ◆ ◆ It's the minutes saved on operations repeated over and over that add up to substantial savings. There's a Hansen coupling for every purpose or pressure requirement—for air, oil, or grease—for oxygen—for acetylene—also the new Hansen two-way shut-off coupling which completely seals both ends of line when disconnected.

Write for Industrial Catalog



Red section shows how rubber washer in valve stem contacts valve seat in both plug and socket, sealing both plug and socket against leakage instantly.



Red section shows flow of liquid or gas around spool section of valve, permitting free flow of liquid or gas through coupling instantly upon connection.

REPRESENTATIVES

New England States:
A. D. GEIGER, Belmont, Mass.
Eastern, Southern States:
B-R ENGRG. CO., Baltimore, Md.
Northern Ohio:
F. & W. URSEM CO., Cleveland, O.
Southern Ohio, West Va., Ky.:
STEINHAGEN AIRLINE PRODUCTS, Dayton, O.
Northern Ill., Eastern Iowa:
NORRIS ENGRG. CO., Chicago, Ill.

Indiana, Wisconsin:
NEFF ENGRG. CO., Ft. Wayne, Ind.
Central Western States:
JOHN HENRY FOSTER CO., St. Louis, Mo., Minneapolis, Minn.
Western, Southwestern States:
BURKLYN CO., Los Angeles, Calif.
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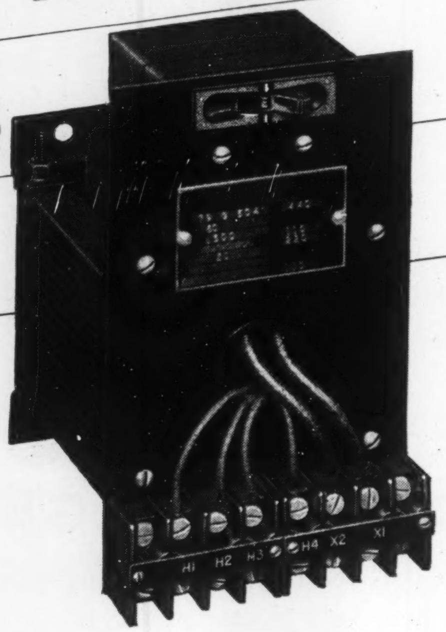
THE HANSEN MANUFACTURING CO.

4031 WEST 150th STREET • CLEVELAND 11, OHIO

Designer's

The Machine Tool Transformer YOU asked us to Build



Yes, here at last is a line of transformers designed specifically for machine tool use. We didn't guess at what you wanted in such transformers. We asked machine-tool designers throughout the country. This new line of G-E machine tool transformers is the result. It incorporates every practical suggestion your profession had to offer.

A COMPLETE RANGE OF RATINGS. Ten ratings, from .075 to 3 kva, 60 cycles, 220/440 volts will meet most of your domestic requirements. For foreign and unusual domestic applications, the line includes an all-purpose group of transformers rated 50/60 cycles, with eight primary taps from 208 to 550 volts. Also available are 25-cycle units in four standard sizes from .150 to .5 kva, with primary taps for 220, 440 and 550 volts.

HARMONIOUS APPEARANCE. The trim good looks of these transformers harmonizes with other modern components to make neat, functional control-panel arrangements.

VOLTAGE REGULATION. Regulation characteristics have been given careful attention to assure satisfactory operation of motor-starting relays which cause heavy momentary overloads. Hence, there is no need for use of greatly oversized transformers to handle momentary surges. To help you select the right transformer, see the complete regulation data in our new machine tool transformer bulletin.

OVERLOAD PROTECTION. These transformers have a built-in overload protector, with time-delay action, to prevent damage under sustained overload or accidental short circuit.

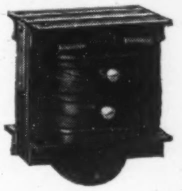
EASY TO INSTALL. With the diagrammatic nameplate, errors in connection are avoided. Only a screw driver is needed to make solid connections on the front-mounted terminal board. Molded-plastic terminal barriers prevent accidental shorts. These new transformers save space, save installation time, and reduce inventories. For full information ask for Bulletin GEA-4887.

GENERAL ELECTRIC

Digest

TIMELY HIGHLIGHTS ON PRODUCTS

SOLENOIDS ARE BACK



This General Electric a-c solenoid is *not* new, but it is currently being built in increasing quantities . . . shipments are short enough now so that you can safely include it in your new designs. The performance record of these units is responsible for their popularity among machine designers.

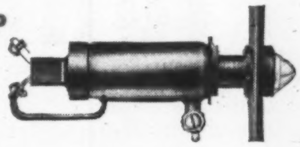
Any straight-line push or pull, from 0.9 to 97 pounds, is easy for this industrial solenoid. It may be operated remotely from a push-button station, or automatically by limit switches, pressure switches, float switches, or other pilot circuit devices. Check Bulletin GEA-2080 on coupon.

VERSATILE HAND "TACH"

Here's a new hand-held electric tachometer for checking performance on your machines. It measures rotational speed in three ranges from 100 to 10,000 rpm; and linear speed in six ranges from 10 to 10,000 fpm. With accessories, you can measure speeds from 10 to 100,000 rpm.

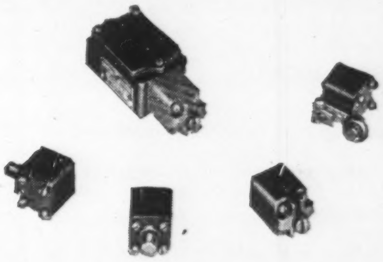
Accuracy of ± 1 per cent is unaffected by magnetic fields, machine vibration, or temperature. Scale is large and easy to read —with no crowding on any range. Speed ranges can be changed while spindle is rotating—and instrument can not be damaged by overspeeding. Requires only $\frac{1}{4}$ ounce-inch driving torque. Measures both clockwise and counterclockwise rotation. See Bulletin GEA-4895.

NEW INDICATING LAMP



The new Type ET-5 indicating lamp is designed to harmonize with modern panel instruments and to give high visibility from any angle. Caps are available in six fast colors. Series resistor limits current in lamp circuit, eliminating need for low current fuses. Two types: for panels up to $\frac{1}{4}$ inch thick and for panels up to 2 inches thick. Check Bulletin GEA-3643.

For positive snap action:
TYPE K-1 LIMIT SWITCH



You can specify any one of four different heads—roller-lever, side push-rod, top push-rod, roller push-rod—on the General Electric Type K-1 snap action limit switch. And you have a choice of four head positions . . . that's real versatility. Snap action means sure, positive operation; contacts always open at the same point.

Cutting fluids and oil will not damage these switches, thanks to oilproof construction. They are physically small (approx. $1\frac{1}{2}$x$3\frac{1}{2}$x$1\frac{3}{8}$ inches), yet handle up to 10 amps at 110/220 volts a-c. Bulletin GEA-4644.

Type J-1 Snap-action Limit Switch, big brother to the Type K-1, is rated 10 amps at 110 volts and will interrupt up to 30 amps. These general-purpose limit switches have gained wide acceptance in industry—are noted for their reliability, ease of installation and versatility of application. Available now! Bulletin GEA-4643.

GENERAL ELECTRIC COMPANY
Apparatus Dept., Section J668-57, Schenectady 5, N. Y.

Please send me the following bulletins:

☐ GEA-4887—Machine-tool Transformers
☐ GEA-3643—Type ET-5 Indicating Lamp
☐ GEA-4895—New Hand Tachometer
☐ GEA-2080—Solenoids
☐ GEA-4644—K-1 Limit Switch
☐ GEA-4643—J-1 Limit Switch

CONSULT YOUR SWEET'S! You'll find "everything electric" for machinery manufacturers in the General Electric section.

NAME...

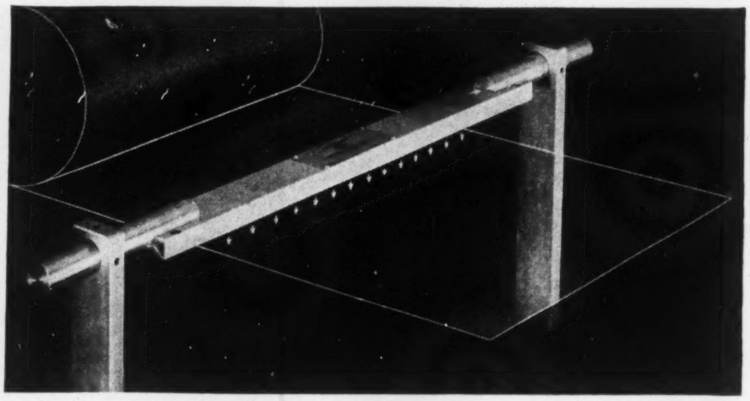
COMPANY...

STREET...

CITY....................... STATE.......................

NOW... putting an end to static troubles...

- *... on coating and finishing machines*
- *... packaging and envelope machines*
- *... printing presses*
- *... production and processing equipment for cellulose sheeting, cellophane, glassine, rubber, synthetics, paper stocks*
- *... textile machinery*
- *... photographic print driers*
- *... microbalances*



The Ionotron employs a *new method* of eliminating static electricity — a unique method with exclusive, basic advantages. Continuous alpha radiation is provided by a radioactive source in a metallic bar-shaped housing of suitable size for the specific equipment. The rays ionize the air in the critical zone. The ionized air "bleeds off" static charges before they can cause trouble. The Ionotron is continuously and permanently effective. No power connection is required, and there's no operating expense!

Interrupted production due to difficulties in handling static-charged materials . . . irregularities in finished products . . . fire and explosion hazards — all these are common problems in operations where friction generates static electricity. The Ionotron Static Eliminator*, a recent achievement of the U. S. Radium Corporation, affords you a simple yet highly effective means of eliminating such problems from the machines you design or the equipment you use.

The efficiency and safety of many types of machines have been increased by the installation of Ionotron units. By incorporating the Ionotron into your design, you can give many machines an important additional sales feature. Application of the Ionotron is so simple that it rarely necessitates any modification of fundamental design.

To find out more about how the Ionotron works, write for Bulletin 8.1. Or, better still, send us a sketch or blueprint and description of any static "trouble spot" you have, and we'll submit specific recommendations, without obligation. Write *Dept. L4, U. S. Radium Corp., 535 Pearl St., New York 17, N. Y.*

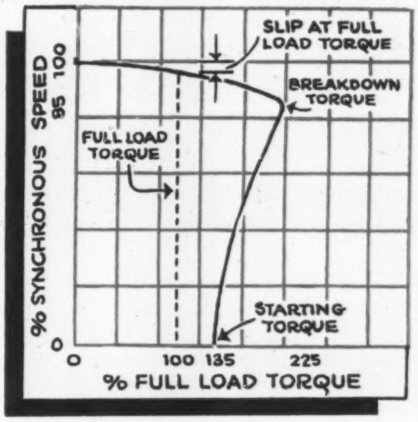
*Trade-mark reg. U. S. Pat. Off.

U S RADIUM

IONOTRON *Static* ELIMINATOR

OTHER PRODUCTS OF U. S. RADIUM: LUMINESCENT MATERIALS: *radioactive, fluorescent, phosphorescent* • **LUMINESCENT DIALS:** *radioactive, fluorescent* • **POWDERS:** *cathode-ray tube · television tube* • **RADIUM LOCATORS:** *pendants, lenses, buttons, screws, markers* • **RADIOACTIVE FOILS** *(alpha-ray ionization sources)* • **HIGH-ACCURACY DIALS** *(nonluminescent)* • **SILHOUETTE ILLUMINATION** *of clocks, watches, and instruments* **LUMINOUS RETICLES** *and other specialties*

Here's *One* Way to Choose Motors...



Sure, Your Local "Swami" can pick a motor for you in an instant! But if you want motor counsel you can *bank* on . . . you'll consult a reputable motor manufacturer. In place of crystal-ball gazing, he'll advise you to follow *practical* and *orderly* steps in arriving at *right* motor selection. For example . . .

First, Study Your Power Supply . . . voltage, frequency, number of phases; the p.f. required by your utility. Judicious selection will help balance your motor capacity . . . lower power costs. And check the voltage regulation — choose motors with enough torque to start and carry the load. Next . . .

Study the Driven Machine and surroundings. What hp? What starting torque? Will you need a horizontal or vertical motor — direct-connected, belt-driven or gear-operated? How about surroundings — ambient temperature, moisture, corrosion, dust. Each calls for a particular type of protection. Now . . .

MOTOR CHARACTERISTICS

Study Your Motor Characteristics. *A-c motors?* For most jobs they're satisfactory and economical. *D-c motors?* For wide speed range; for fast acceleration or reversal they may prove your best bet. *Synchronous motors?* When applicable they give you low-cost p.f. correction. You're *still* undecided? Call in your nearby Allis-Chalmers motor expert. He'll be glad to help you decide—with recommendations backed by 50 years of motor-building!

Wise Motor Choice Saves Power; Ups Profit!

YES, CRYSTAL-BALL GAZING methods are out when you're trying to get *maximum* return on your electric motor investment. Slip-shod selection usually results in over-capacity, high power and maintenance bills — the kind of costs that in the competitive era of tomorrow you won't be able to afford!

That's why it pays to know more about *all* types of motors . . . their operation . . . limitations . . . maintenance. And there, too, is where your Allis-Chalmers motor expert can be of real help! ALLIS-CHALMERS, MILWAUKEE.

A 2328

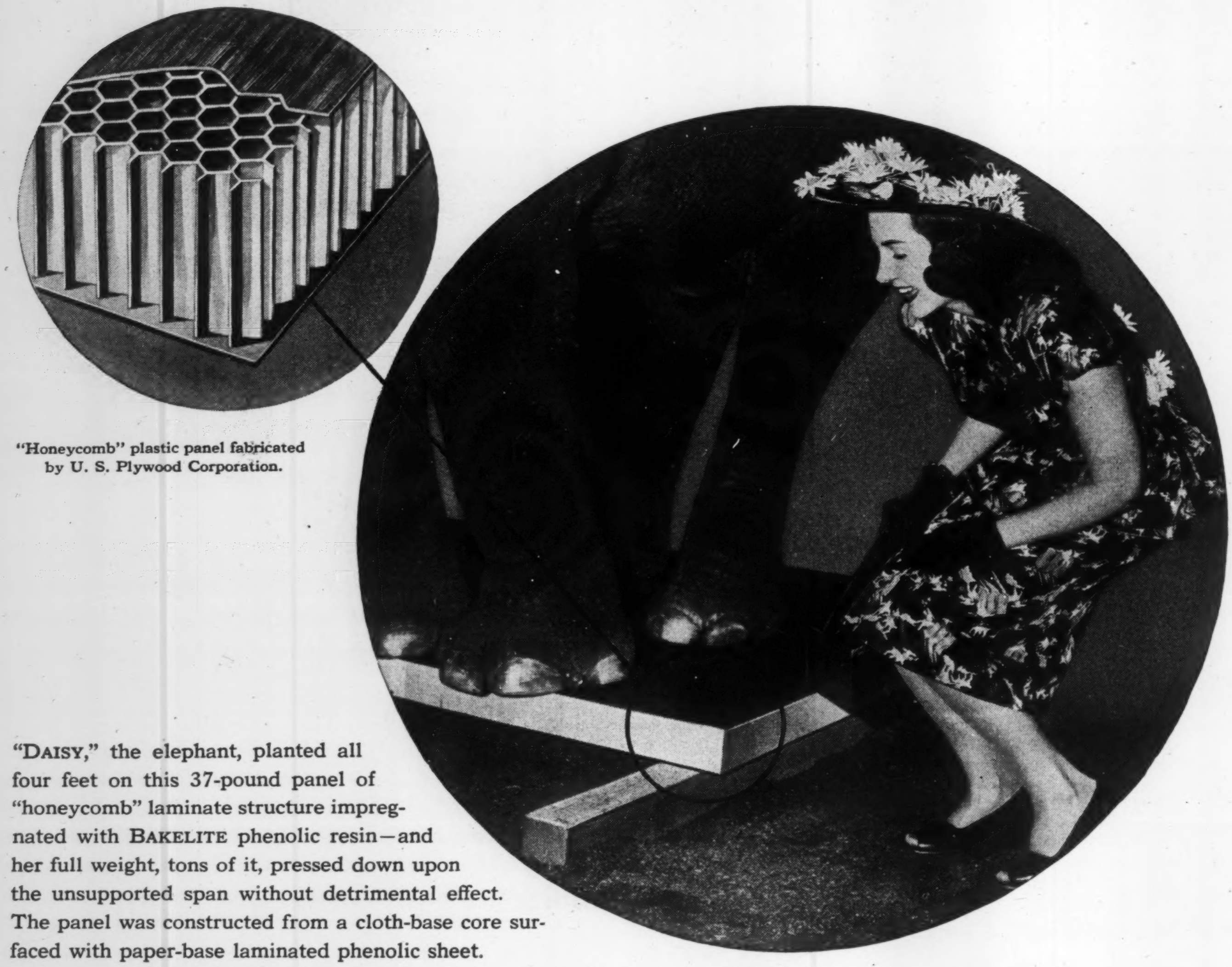
1847 1947
A CENTURY OF SERVICE to Industry THAT MADE America Great

ALLIS-CHALMERS

**One of the Big 3 in Electric Power Equipment-
Biggest of All in Range of Industrial Products**

Honeycomb Plastic—Pound for Pound

The Strongest Material Ever Made!



"Honeycomb" plastic panel fabricated by U. S. Plywood Corporation.

"DAISY," the elephant, planted all four feet on this 37-pound panel of "honeycomb" laminate structure impregnated with BAKELITE phenolic resin—and her full weight, tons of it, pressed down upon the unsupported span without detrimental effect. The panel was constructed from a cloth-base core surfaced with paper-base laminated phenolic sheet.

Thus "Daisy" confirmed, in her unscientific but convincing way, the exhaustive laboratory tests to which this material has been subjected. As a matter of fact, this "honeycomb" panel, 4′ x 3′ x 3¼″, offered "Daisy" a wide margin of safety. It could hold 25,000 pounds at mid-span without failure.

Enormous strength is *inherent* in this new structural material. Designers and engineers in many industries are now studying its possibilities for weight-saving and product improvement. It was developed for aircraft uses—but it is ready for scores of other applications.

The structure can be built of paper, cloth, or glass cloth core, impregnated with BAKELITE phenolic resin, sandwiched between sheets of plywood, aluminum, plastic laminates, or other material. It is highly resistant to moisture, "weathering" and age. It may be had in a range of dimensions up to 5′ x 10′ panels with cores varying from ¼″ to 3″ or more in thickness. Certain constructions can be sawed like wood.

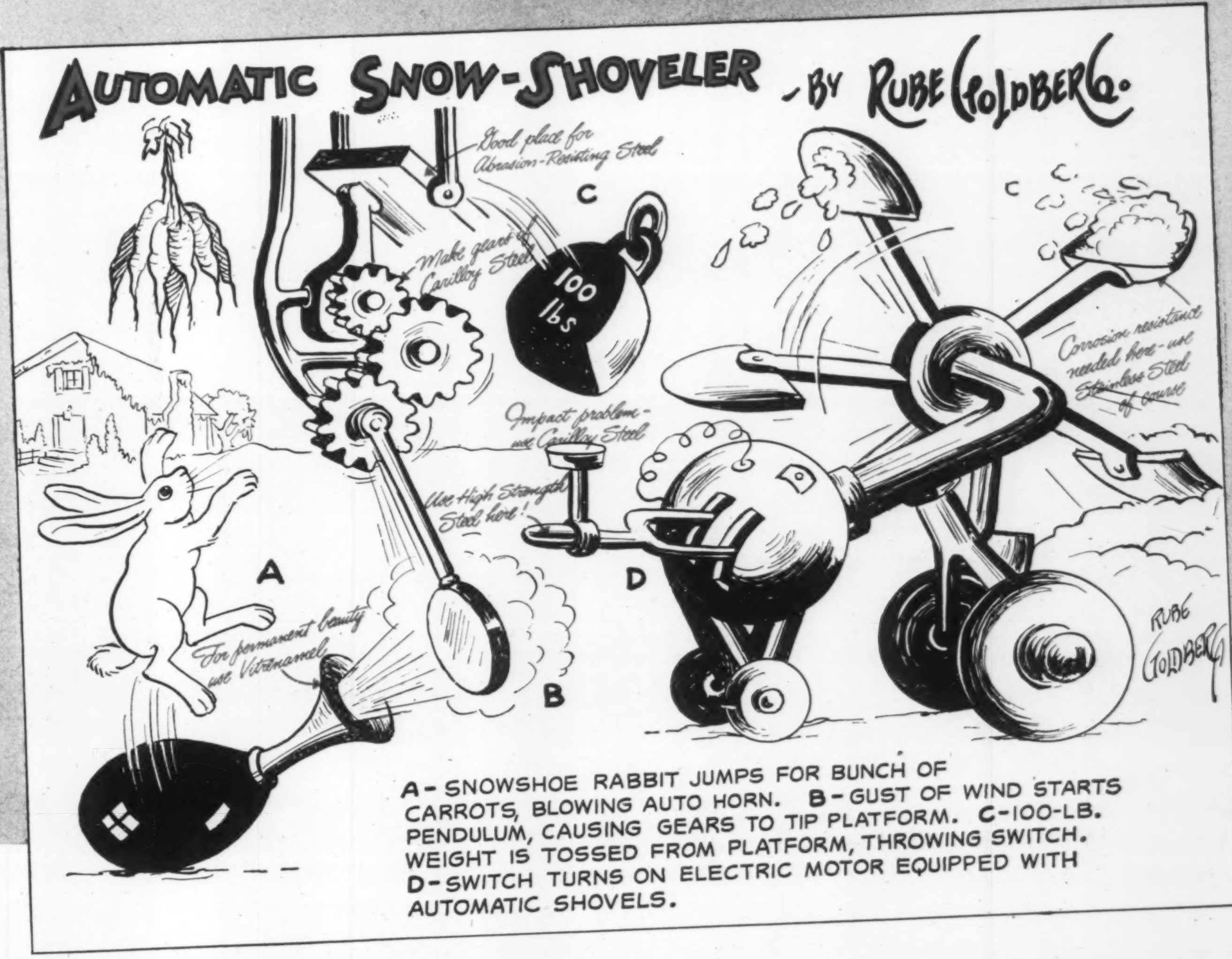
Address Department 18 for prompt handling of your inquiry.

TRADE-MARKS

BAKELITE

LAMINATING PLASTICS

BAKELITE CORPORATION, *Unit of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N.Y.


AUTOMATIC SNOW-SHOVELER - BY RUBE GOLDBERG Co.
Good place for Abrasion-Resisting Steel
C
Make gears of Carilloy Steel
100 lbs
Impact problem - use Carilloy Steel
Use High Strength Steel here!
Corrosion resistance needed here - use ~~Stainless~~ Steel of course
A
For permanent beauty use Vitrenamel
B
D
RUBE GOLDBERG

A - SNOWSHOE RABBIT JUMPS FOR BUNCH OF CARROTS, BLOWING AUTO HORN. B - GUST OF WIND STARTS PENDULUM, CAUSING GEARS TO TIP PLATFORM. C - 100-LB. WEIGHT IS TOSSED FROM PLATFORM, THROWING SWITCH. D - SWITCH TURNS ON ELECTRIC MOTOR EQUIPPED WITH AUTOMATIC SHOVELS.

While design engineers could undoubtedly think of a much more practical way of shoveling snow, they'd probably agree with one fact brought out by Mr. Goldberg's cartoon. Only steel can do so many jobs so well.

When a product needs rugged strength, toughness, light weight and high resistance to corrosion—when it must withstand intense heat or cold—when protection against fatigue, sudden shock or abrasion are imperative — when good looks and low price are important factors . . . then steel will usually provide the most practical and economical solution.

Steel can be polished to mirror surface, plated, galvanized, painted, or permanently coated with porcelain enamel to add more beauty and to increase sales appeal.

It can be deep drawn, forged, cut, twisted and bent. You can weld it to perfection, rivet, punch and even stitch it. Its use involves no unfamiliar fabricating problems.

Our steel specialists will be glad to assist you in applying special purpose U·S·S Steels to your products to help make them more durable, more efficient, less costly to manufacture, and easier to sell.

CARNEGIE-ILLINOIS STEEL CORPORATION
Pittsburgh and Chicago
COLUMBIA STEEL COMPANY, San Francisco, Pacific Coast Distributors
TENNESSEE COAL, IRON & RAILROAD COMPANY, Birmingham, Southern Distributors
UNITED STATES STEEL SUPPLY COMPANY, Chicago, Warehouse Distributors
UNITED STATES STEEL EXPORT COMPANY, New York
7-1079

Have you explored the possibilities of these special purpose U·S·S Steels?

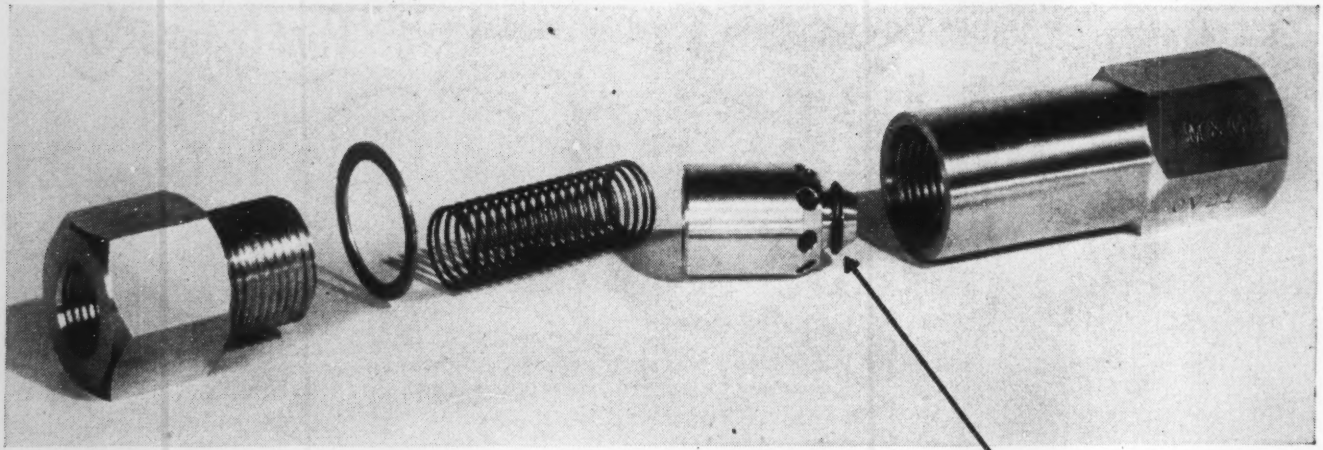
- **U·S·S STAINLESS AND HEAT-RESISTING STEELS** to assure high resistance to corrosion and heat, and to reduce weight.
- **U·S·S CARILLOY STEELS**—Alloy steels for the special jobs of industry.
- **U·S·S HIGH STRENGTH STEELS** to resist atmospheric corrosion, to increase strength without adding weight or to maintain strength with reduced weight.
- **U·S·S COPPER STEEL** to give at least twice the atmospheric corrosion resistance of regular steel at little additional cost.
- **U·S·S ABRASION-RESISTING STEEL** to combat wear and friction.
- **U·S·S HOT-ROLLED AND COLD-ROLLED STEELS** to provide the basic advantages of steel, plus maximum economy in each job.
- **U·S·S PAINTBOND**—A galvanized, Bonderized sheet that permits immediate painting and holds paint tighter.
- **U·S·S VITRENAMEL**—Sheets designed especially for porcelain enameling.
- **U·S·S ELECTRICAL SHEETS** for motors, generators and transformers.

9 times out of 10
STEEL
will do it better

USS STEEL UNITED STATES STEEL

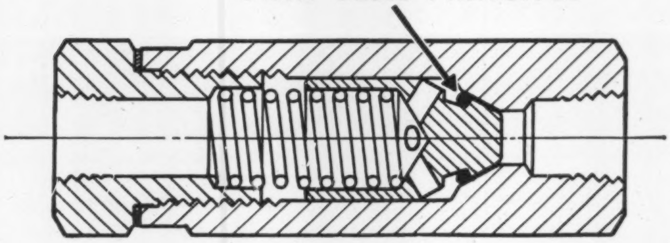
IT TAKES SCRAP TO MAKE STEEL . . . PLEASE TURN YOURS IN!

UNITED STATES STEEL



"O" rings make Perfect Seals at 15,000 psi—

even with Grit in the System!



Effectively combining the conventional metal to metal seat with a resilient Linear "O" ring seal makes a tight check valve—completely dependable at 15,000 psi. It can be operated with oil, air, water or any liquid not destructive to synthetic and natural rubber.

Linear "O" rings, used in the Mansfield & Green Twin Seal Check Valve, are absolutely tight and show the simplicity of an "O" ring installation. The "O" ring, a tight seal against high pressures, works equally well on low pressures or vacuums.

Linear "O" ring packings, precision moulded to close tolerances, are made of highly resilient synthetic rubber compounds and are adaptable to a wide range of temperatures, pressures and fluids.

Many tough problems are being solved by Linear design and skill. Linear's facilities and engineering experience are available to you. Get complete data by sending a statement of maximum pressure, temperature range and the fluid to be handled.

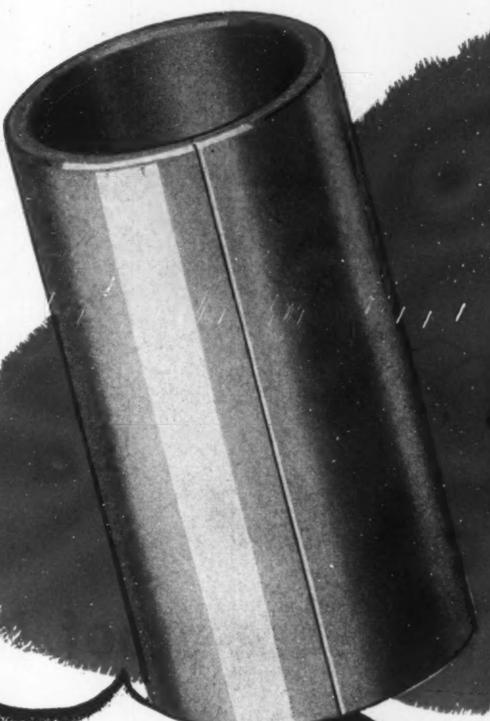
LINEAR **LINEAR** INCORPORATED **OVER FORTY YEARS PACKING EXPERIENCE**

Executive Offices and Factory
STATE ROAD and LEVICK STREET—PHILADELPHIA 35, PENNA.

Wichita City Library

another typical example of how

THE FORMETAL IQ* means lower costs to you



What could you do with $18,600.00* savings in bushing or bearing costs?

to get your product really rolling..use

FORMETAL

Superformed

BUSHINGS AND BEARINGS

A manufacturer of automotive assemblies early this year replaced the ordinary bushings he was using with FORMETAL Superformed Bushings. A recent check-up showed that he had already made a savings of $18,600 on this one item . . . besides a definite improvement in performance. With manufacturing costs increasing, savings like these are *vital* to profitable operation today.

If you use bushings or bearings, you ought to know about FORMETAL's *Improved Quality... because it may mean tremendous savings to you. The exclusive qualities of FORMETAL Superformed Bushings and Bearings offer you many opportunities for improvement at a saving. In a FORMETAL Bushing you can often use a thinner wall to provide the same strength as the thick wall of an ordinary bushing. You can have a higher Rockwell hardness without loss of machinability. Custom-made oil grooves—vital to long and smooth performance are engineered to your requirement.

Could you use a savings of thousands of dollars? Certainly! Then do this today—investigate the advantages of using FORMETAL Bushings or Bearings—made of bronze, steel, or an alloy to your specification. Write for free catalog. Engineers and buyers of bushings, bearings, and spacer tubes will find it an extremely valuable reference book.

*One of a series of cases in which Formetal has saved varying sums of money for manufacturers.

National Formetal Co., Inc., 6604 Metta Ave., Cleveland 14, Ohio

Please send free copy of your reference catalog.

Name..............................

Company..............................

Product manufactured..............................

Address..............................

City and State..............................

NATIONAL FORMETAL CO., INC.

ESTABLISHED 1919

Manufacturers of "Superformed" Bushings and Bearings ..and Spacer Tubes

6604 METTA AVENUE - CLEVELAND 14, OHIO

Offices in DETROIT • CHICAGO • LOS ANGELES • INDIANAPOLIS • NEW YORK

TWICE THE METAL
AT THE SEAT
SAFELY WITHSTANDS
OVER-TORQUEING

Assures leakproof, pressure-proof joints

TUBING BUYERS who want super-strong joints should get a good look at the Bundy double flare.

You can *see* why this flare is superior. It is Bundyweld* Tubing formed to double thickness at the seat, and always held to close tolerances.

The result is added strength to overcome stresses due to over-torqueing, high pressure or excessive vibration. With Bundy double flare, joints are leakproof and pressure proof.

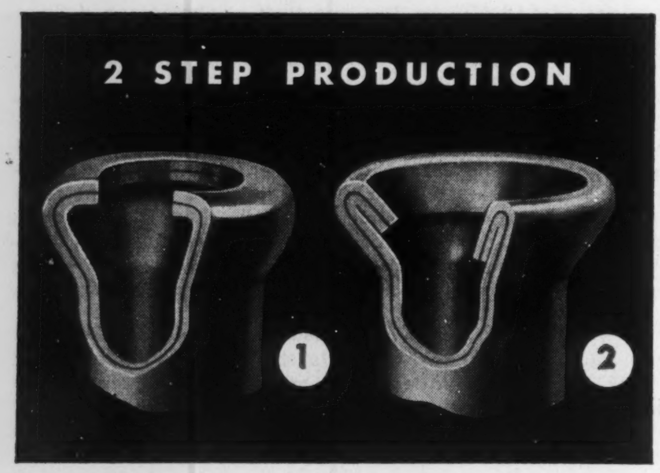
10 million a month

Up to 10 million double flares a month are produced by Bundy. It has proved its worth in more than 16 years of usage. Furthermore, it has been adopted as a standard by the Society of Automotive Engineers.

But that isn't all about Bundyweld!

Stove makers, Diesel engine manufacturers, makers of refrigeration and cooling device equipment, and many other manufacturers have picked Bundyweld Tubing with its unique, double-wall construction.

Are *you* on the hunt for superior tubing? Investigate Bundyweld. Available in steel, Monel and nickel. Call or write *Bundy Tubing Company, Detroit 14, Michigan.*



Leakproof, pressure-proof joints are assured by Bundy double flare. Frequent removals and replacements of fittings are also possible. This flare is made by hand or machine tools to accommodate any standard fitting.

BUNDY TUBING

ENGINEERED TO YOUR EXPECTATIONS

*REG. U.S. PAT. OFF.

BUNDY TUBING DISTRIBUTORS AND REPRESENTATIVES:

Pacific Metals Co., Ltd.
3100 19th St.
San Francisco 10, Calif.

Standard Tube Sales Corp.
76-01 Woodhaven Blvd.
Brooklyn 27, N.Y.

Lapham-Hickey Co.
3333 W. 47th Place
Chicago 32, Illinois

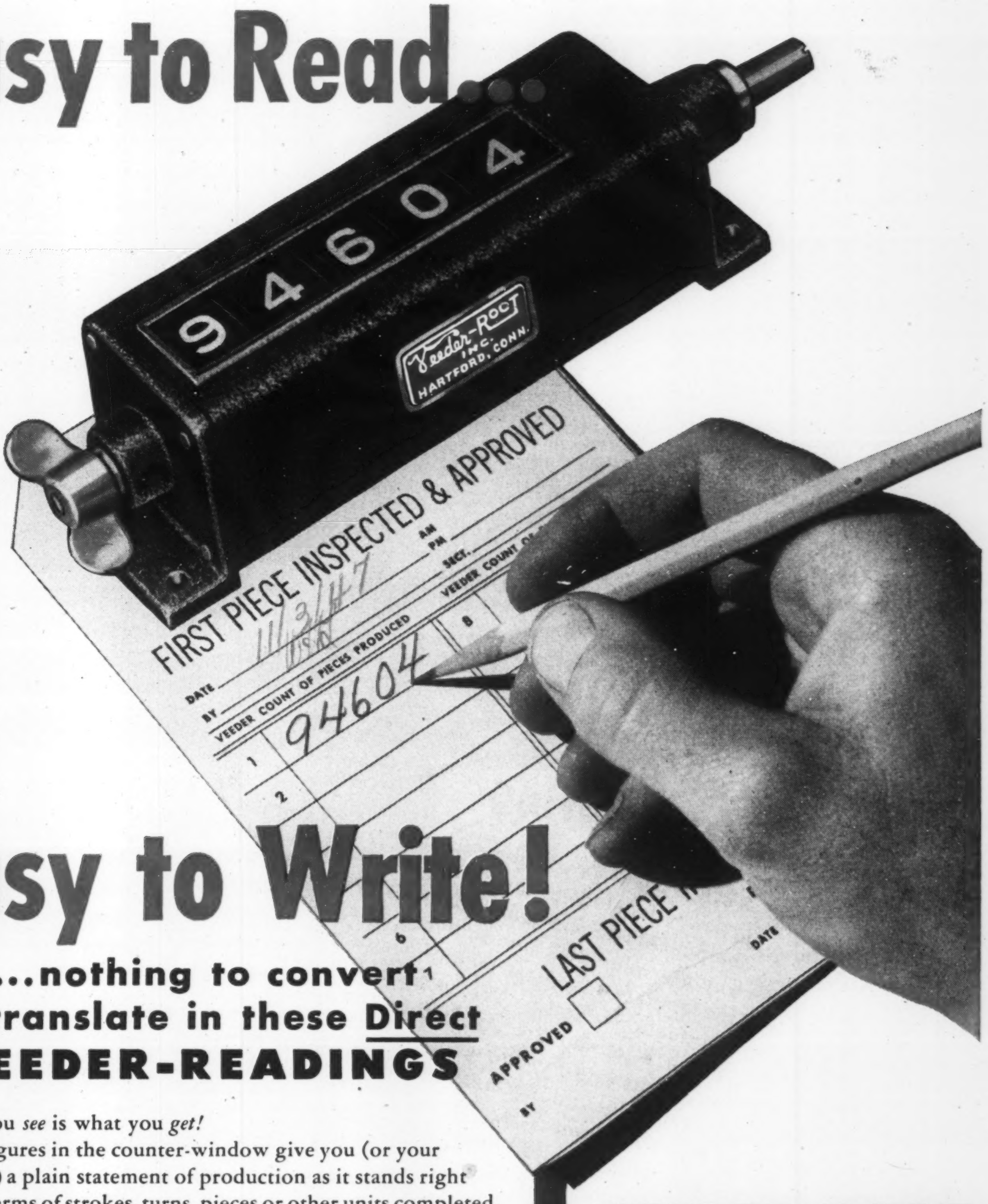
Rutan & Co.
404 Architects Bldg.
Phila. 3, Pa.

Eagle Metals Co.
3628 E. Marginal Way
Seattle 4, Wash.

Alloy Metal Sales, Ltd.
861 Bay St.
Toronto 5, Canada

Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg., Chattanooga 2, Tenn.

Easy to Read...



9 4 6 0 4
Veeder-Root Inc. Hartford, Conn.
FIRST PIECE INSPECTED & APPROVED
DATE
11/3/47
AM
PM
BY
SECT.
VEEDER COUNT OF PIECES PRODUCED
94604
VEEDER COUNT OF
1
2
6
8
LAST PIECE I
DATE
APPROVED
BY

Easy to Write!

...nothing to convert or translate in these Direct VEEDER-READINGS

What you *see* is what you *get!*

Those figures in the counter-window give you (or your inspectors) a plain statement of production as it stands right now—in terms of strokes, turns, pieces or other units completed.

And those same figures, in other ways, can help your machine-operators, too—by enabling them, for instance, to pre-set depth of cut on a machine *in numerical thousandths,* instead of fussing around with dial-graduations. This saves important money in time and errors.

That's one reason why more and more designers are figuring out jobs for Veeder-Root Devices, *and then building them right into their machines.*

And no matter how *you* figure, you can count on Veeder-Root Devices for this:

Read 'em and reap! Yes, reap more benefits than you can even begin to imagine now. *Like to learn more?* Write.

VEEDER-ROOT
INCORPORATED

HARTFORD 2, CONNECTICUT

In Canada: Veeder-Root of Canada, Ltd., 955 St. James St., Montreal 3.

In England: Veeder-Root Ltd., Dickinson Works, 20 Purley Way, Croydon, Surrey.

NOW AT *Accurate*

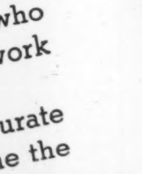
ACCURATE SPRING MFG. CO.
SPRINGS
WIRE FORMS
STAMPINGS

The new modern Accurate plant

...an even better spring service...

It gives us pleasure to announce that we are now located in our new quarters on the site of the old main plant which was destroyed by fire in March of this year. The new plant, modern in every detail, has been laid out to incorporate the latest techniques of material handling and production control. The same skilled springmakers who made Accurate Springs before the fire are back at work using the latest type machines.

What does all this mean to you? It means that now Accurate offers an ***even better*** spring service. We will welcome the opportunity to tell you more about what Accurate offers a company like yours.



- *Ask for a copy of the Accurate Spring Handbook. It's full of helpful short-cuts for making spring calculations.*

ACCURATE SPRING MFG. CO.
3813 W. Lake Street, Chicago 24, Illinois

Springs • Wire Forms • Stampings

Accurate Springs

MADISON-KIPP ALUMINUM DIE CASTINGS
The Telling Touch of Eye Appeal!

Pressure cooker and sauce pan handle sockets were considered as mostly functional components until the die casting process was utilized. Madison-Kipp aluminum die cast sockets in extremely large quantities have been produced, not only for economy and function, but for eye appeal as well.

The illustrations in this advertisement show a socket that definitely improved the product design.

Madison-Kipp may be able to do a good casting job for you.

MADISON-KIPP CORPORATION

210 WAUBESA STREET, MADISON 4, WISCONSIN, U. S. A.

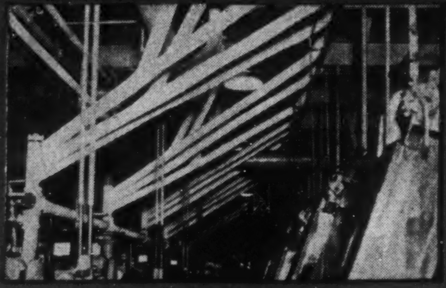
ANCIENS ATELIERS GASQUY, 31 Rue du Marias, Brussels, Belgium, sole agents for Belgium, Holland, France, and Switzerland.

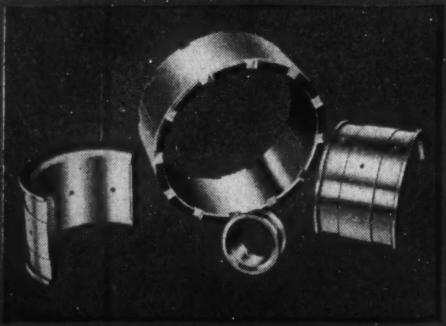
WM. COULTHARD & CO. Ltd., Carlisle, England, sole agents for England, most European countries, India, Australia, and New Zealand.

- *Skilled in* DIE CASTING *Mechanics*
- *Experienced in* LUBRICATION *Engineering*
- *Originators of Really High Speed* AIR TOOLS

Tubes.... for all purposes from one dependable source

... FOR POWER PLANTS


... FOR PRODUCTION PROCESSES


... FOR MECHANICAL PARTS

WELDED
SEAMLESS

B & W MAKES BOTH

B&W is the one place you can get both Seamless and Welded steel tubes for any requirement in power plants, production processes, or for mechanical uses. B&W Tubes cover the widest variety of analyses available from a single source—from low carbons to high alloys, including a full range of stainless steels of the ferritic and austenitic groups; carbon-molybdenum, S.A.E. and Nitralloy steels, and Croloy grades developed by B&W. By centralizing your tube requirements for all purposes at B&W you simplify tube engineering and purchasing problems. In many cases, authorized distributors in all principal cities can fill your orders promptly from local warehouse stocks of B&W tubes.

TA-1433M

Seamless and Welded Tubular Products in a full range of Carbon, Alloy, and Stainless Steels for All Pressure and Mechanical Applications.

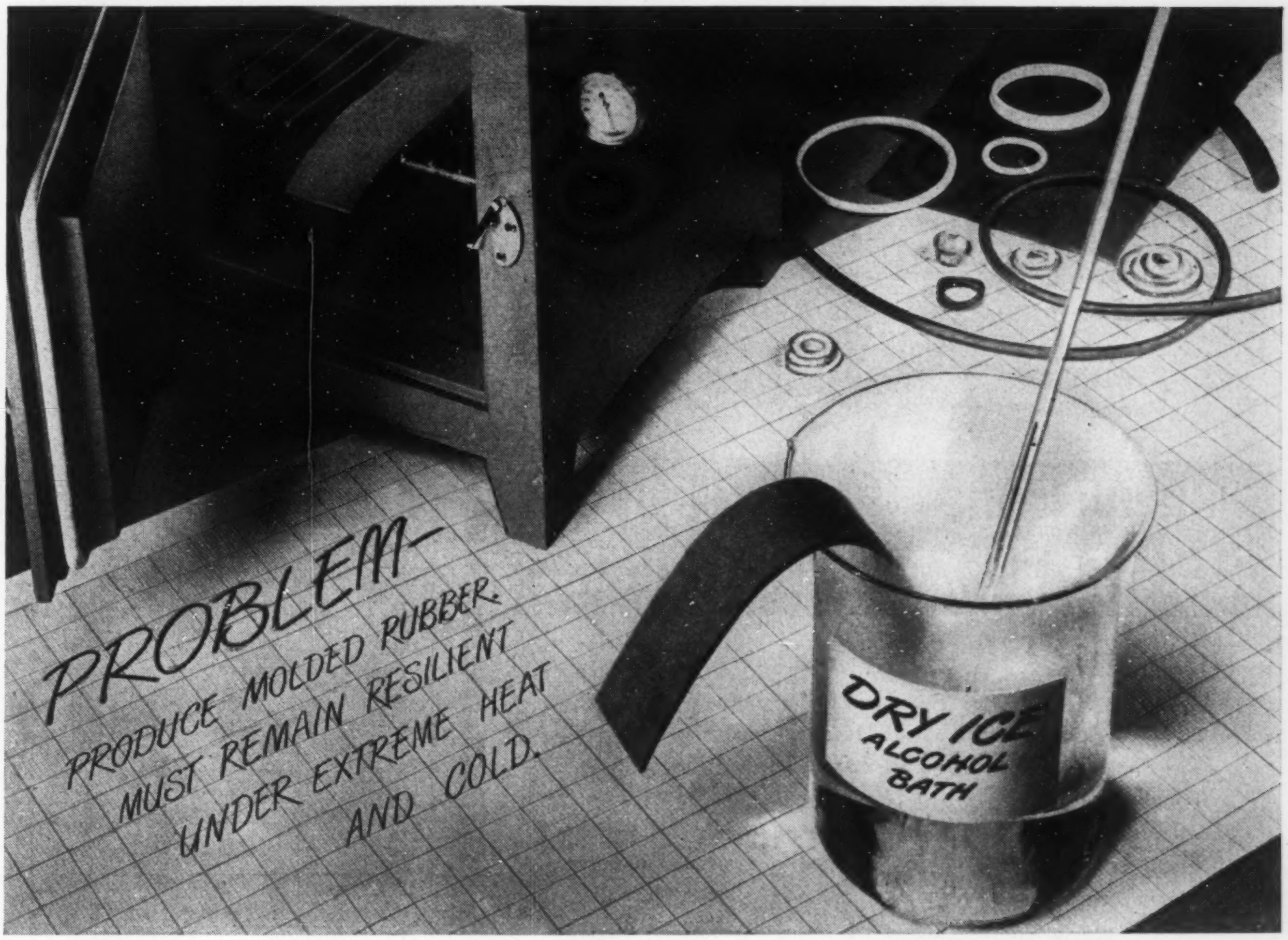
* * *

Other B&W Products
THE BABCOCK & WILCOX CO.
85 LIBERTY STREET · NEW YORK 6, N.Y.

Stationary and Marine Boilers . . . Boiler Components . . . Pulverizers . . . Fuel Burning Equipment . . . Refractories . . . Chemical Recovery Units . . . Process Equipment . . . Alloy Castings

BABCOCK & WILCOX
SEAMLESS & WELDED TUBES
THE BABCOCK & WILCOX TUBE COMPANY
GENERAL OFFICES: BEAVER FALLS, PA.
PLANTS: BEAVER FALLS, PA. AND ALLIANCE, OHIO.

• ENGINEERED AND MOLDED AT NO. 1 PLASTICS AVENUE



Ever see rubber like this?

• Here's an amazing kind of rubber! Bake it in an oven, immerse it in a dry ice bath, and it remains resilient and flexible. It's the new General Electric silicone rubber that withstands heat up to 520 F, cold down to —55 F.

Improved molding and fabricating techniques used by General Electric make possible a whole new field of applications for this remarkable silicone product. Used during the war for gaskets in high-heat searchlights and airplane superchargers, General Electric silicone rubber is now being applied extensively to electrical equipment of many types, heat-sealing apparatus, baking ovens, diesel engines and high-vacuum systems.

The successful application of this remarkable material to many industrial products grows out of General Electric's complete plastics service—equipped to design, engineer and mold all types of plastics to meet your individual requirements. For more information on silicones, or plastics, write Chemical Department, General Electric Company, Pittsfield, Mass.

GENERAL ELECTRIC

CD 47-H-14

GENERAL ELECTRIC PLASTICS FACTORIES ARE LOCATED IN SCRANTON, PA., MERIDEN, CONN., COSHOCTON, OHIO, FORT WAYNE, IND., TAUNTON AND PITTSFIELD, MASS.

G-E Complete Service—Everything in Plastics

BACKED BY 53 YEARS OF EXPERIENCE. We've been designing and manufacturing plastics products ever since 1894. G-E research works continually to develop new materials, new processes, new applications.

NO. 1 PLASTICS AVENUE—complete plastics service—engineering, design and mold-making. Our own industrial designers and engineers, working together, create plastics parts that are both scientifically sound and good-looking. Our own toolrooms are manned by skilled craftsmen—average precision mold experience, over 13 years.

ALL TYPES OF PLASTICS. Facilities for compression, injection, transfer and cold molding ... for both high and low pressure laminating ... for fabricating. G-E Quality Control—a byword in industry—means as many as 160 inspections and analyses for a single plastics part.

EVERYTHING IN
Plastics

SCHEDULE OF RING SIZES FOR R/M VEE-FLEX PACKING RINGS

R/M Vee-Flex packing rings can be manufactured to any required diameter up to several feet. For each diameter size, the rings may be secured in the dimensions shown in the schedule herewith.

These rings insure a positive and long-lasting seal against liquid or gas. Different types of material are used to meet *special* conditions, as in the food, chemical and oil industries.

The special construction of the Vee-Flex rings allows the rings to nest together so that more rings can be fitted into shallow stuffing boxes than would otherwise be possible. Each ring operates as a separate seal to control pressure, and the greater the number of rings in a set, the greater the sealing ability and the longer the service life.

While Vee-Flex rings are used on all types of oscillating and reciprocating and rotating shafts, they have served successfully on many unusual applications such as accumulators, hydraulic presses, triplex pumps, telemotors, hydraulic elevators, stems on heavy duty valves, aeroplane shock absorbers and inside packed piston pumps.

Specify R/M Vee-Flex rings on the equipment you are now designing. Put them in your bill of materials. An R/M engineer will be glad to discuss Vee-Flex rings and other R/M packings at any time. For full information, or for your copy of the new Vee-Flex bulletin, write Asbestos Textile & Packing Division, Raybestos-Manhattan, Inc., Manheim, Pa.

SIZE	Depth of First Ring	Depth of Each Additional
1/4″	.204	.106
5/16″	.255	.133
3/8″	.306	.159
7/16″	.354	.184
1/2″	.408	.212
9/16″	.459	.239
5/8″	.509	.265
11/16″	.561	.292
3/4″	.611	.318
13/16″	.662	.344
7/8″	.713	.371
15/16″	.764	.398
1″	.815	.424
1 1/16″	.866	.451
1 1/8″	.917	.477
1 3/16″	.968	.504
1 1/4″	1.019	.530
1 5/16″	1.070	.557
1 3/8″	1.121	.583
1 7/16″	1.169	.608
1 1/2″	1.223	.636

Above depths subject to normal manufacturing tolerances.

RAYBESTOS R M MANHATTAN

RAYBESTOS-MANHATTAN, INC.

ASBESTOS TEXTILE & PACKING DIVISION

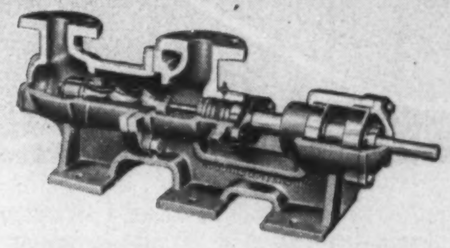
Manheim, Pa. • Bridgeport, Conn. • North Charleston, S. C. • Passaic, N. J.

It's "Packed with Satisfaction" When You Use R/M

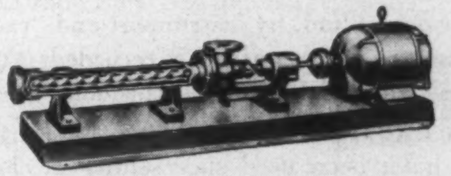
RM

Pumping Action that GETS Action!

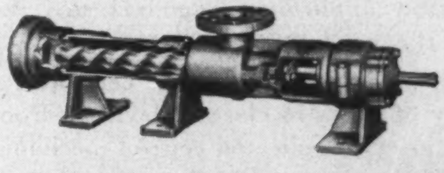
R & M MOYNO PUMPS FOR EVERY PURPOSE



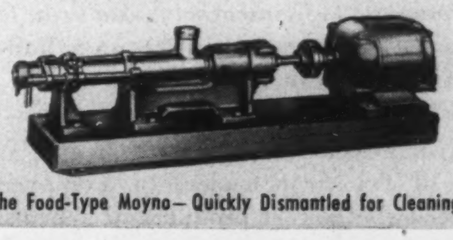
The "Standard" Moyno—for General Service



The Tubular Moyno—for Higher Pressures



The Cradle-Mounted Moyno—for Volatile Liquids



The Food-Type Moyno—Quickly Dismantled for Cleaning

Do your pumps falter and *fade out of the picture* just when you need them most? If so, you should know about "helical-gear" pumping—the action that *gets* action, always!

WORLD'S SIMPLEST PUMPING PRINCIPLE

Nothing could be simpler. The single moving part—a helical rotor—rolls around within a stator to form *continuously sealed* progressing cavities. Self-priming pumping action *starts instantly*—pumps virtually everything from volatile liquids to *non-pourable* pastes. R & M Moyno helical-gear pumps do everything well.

NO OTHER PUMP LIKE THIS

Moynos have no pistons, cylinders, or valves, yet they deliver positive pressures up to 1000 p.s.i., *without pulsation.* They meter flow, pass particles and solids in suspension, resist chemicals and abrasives—*stand up* where other pumps fail.

LICK PUMPING PROBLEMS

So, if you're bothered by materials tough to pump, or that *other types* of pumps won't handle, call in a Moyno Man. The amazing Moyno can serve you too, just as it has *so many* thousands of others. Distributors from coast to coast.

Turn for the Better
R-M MOYNO PUMP

Write today for free 16-page booklet, "A Turn for the Better." It gives capacities, dimensions. uses.

ROBBINS & MYERS · INC. MOYNO PUMP DIVISION
Springfield 99, Ohio • Brantford, Ontario

MOTORS • HOISTS • CRANES • FANS • MOYNO PUMPS • FOUNDED 1878

Keeping flyers
under cover

THEY never leave the ground in a Link trainer. All their "flying" is done blind, by instrument and "radio beam," and every movement of the controls is recorded. The recording device is powered by a Telechron synchronous electric motor.

Such an application is not unusual for these versatile motors. They have been used successfully in clocks, and timing and instrumentation devices for 25 years—and more. Every day Telechron *application engineers* are helping manufacturers adapt them to new and important uses.

Dependable, self-starting Telechron motors meet a wide variety of needs in electric devices—from the simplest switch to the most complicated control mechanism. They reach rated speed almost instantly and operate in perfect synchronism with any commercial frequency . . . *can't run faster or slower*. Torque ratings are conservative. Precision building and Telechron's exclusive sealed-in oiling system assure accurate service and long life.

With a Telechron motor you give your product the plus value of Telechron leadership. For over 25 years, Telechron has been the largest producer of synchronous electric motors. Every one is Underwriters Laboratories approved. Telechron *application engineers* will be glad to discuss your needs. Address Motor Advisory Service, Dept. C, Telechron Inc., Ashland, Massachusetts.

see our
CATALOG
in
SWEET'S FILE
for PRODUCT DESIGNERS

Telechron Motors Are Now Being Used for:

- Stoker, Oil Burner and Temperature Controls
- Industrial Process and Cycling Timers
- Business Machinery
- Medical Devices
- Household Appliance Timers
- Musical Devices

Telechron
REG. U. S. PAT. OFF.
SYNCHRONOUS MOTORS

The first and favorite synchronous electric timing motor

Here's why RELIANCE RINGS ARE MADE FROM Keystone Sections

I GET .188
.065 HERE, TOO
.065 THIS WAY
CHECK! .188

When a flat or square section of wire is used to form a snap ring around an arbor, there is a natural displacement of metal resulting in a definite keystoning of the section and nonparallel surfaces on the snap ring. See figure 1.

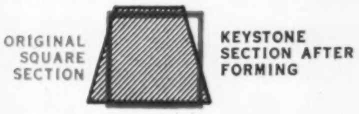

ORIGINAL SQUARE SECTION
KEYSTONE SECTION AFTER FORMING

Fig. 1

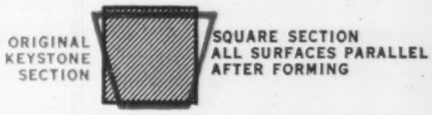
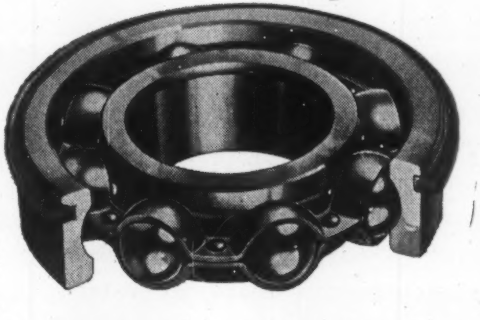

ORIGINAL KEYSTONE SECTION
SQUARE SECTION ALL SURFACES PARALLEL AFTER FORMING

Fig. 2

That's why Reliance Rings are formed from predetermined keystone sections of wire that anticipate the normal and natural flow of metal to form snap rings with flat and parallel surfaces. See figure 2.

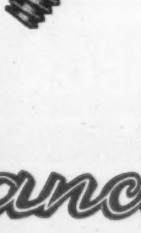
Here, then, is the perfect snap, bearing, lock or retainer ring with wobble-free performance. All Reliance Rings have round or radiused edges depending on application to insure true fit in the milled groove. End cuts designed for easy-on, easy-off assembly.

Send today for complete information and facts about Reliance rings.



TYPICAL APPLICATION

External bearing application of Reliance Ring provides maximum efficiency at lowest cost. Would Reliance Rings' advantages help you in some production or design application?



EATON SPRINGTITES

The all in one unit, quality spring lock washer preassembled on a bolt or screw Cuts production cost by increasing production efficiency.

SPRING WASHERS

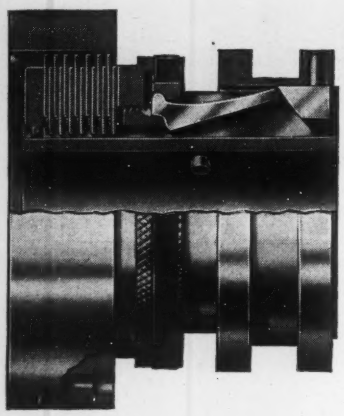
Reliance Spring Lock Washers compensate for normal wear . . . hold bolts, nuts, screws tighter longer.

EATON
EATON MANUFACTURING COMPANY

MASSILLON, OHIO
Reliance Division

Sales Offices: New York • Cleveland • Detroit • Chicago • St. Louis • San Francisco • Montreal

69 EXHIBITORS AT MACHINE TOOL SHOW WERE MAXITORQ USERS!



MAXITORQ CLUTCHES

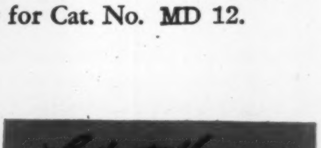
were conspicuous "by their presence" in booth after booth . . . smoothly transmitting power on nationally known machines in operation.

This Floating Disc Maxitorq of ours was certainly in good company . . . and it is fast gaining new friends, new original equipment selections for varied types of machinery not on exhibition at the show.

And there are good reasons why . . . points of superiority in design principles, construction and adjustment, that are exclusively Maxitorq.

For instance; Separator Springs that "float" the discs apart in neutral to prevent drag, abrasion, heating. Manual adjustment, take-apart, assembly . . . no tools required. Then too, clutches are completely assembled on the body, shipped ready to slip onto a shaft.

There are many other Maxitorq details that machine designers and machinery manufacturers should know, and they are all covered in the new catalog available on request. Write us today for Cat. No. MD 12.



THE CARLYLE JOHNSON MACHINE COMPANY
MANCHESTER • CONNECTICUT

"Bandage" for a 1400-degree burn

The engine cones and tailpipes of jet planes throb with 1400 degrees of destructive heat.

1400 degrees, hungry to eat the strength out of neighboring structural members.

1400 degrees that could break a plane in flight.

No wonder the U. S. Army commanded: *"Develop a safe insulation. Maximum temperature on the cold side to be 200° F."*

The problem could have been tough. But Johns-Manville already knew of a metal that could fight heat and come out a "winner." *Inconel*!*

J-M had used this metal in developing a mesh packing to seal joints in exhaust manifolds.

This packing could endure temperatures up to 2000° F. *(Maybe,* thought J-M engineers, *Inconel is the answer here, too.)*

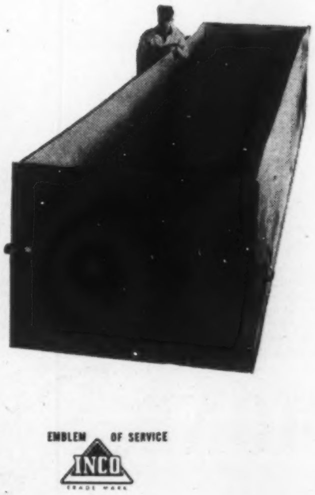
It was!

In the J-M Thermoflex blankets that now protect jet planes from their own heat, there are two layers of Inconel mesh containing asbestos. Placed directly on the 1400-degree surface, they help keep the cold-side temperature below 200° F.

Thermoflex blankets also may answer insulating problems in power, marine and processing applications.

"CUT-RATE" CORROSION RESISTANCE

"Task metals" are used in many ways. Here's a heat-treating tank made of "L" Nickel Clad Steel. "L" Nickel is a special low-carbon Nickel, well able to resist corrosion by molten sodium nitrate at 920° F. Since only a surface of this material was needed, use of Lukens Clad Steel—rather than solid plates of "L" Nickel — was an economical solution. Write for booklet, "Lukens Clad Steels."*



INCONEL *vs.* HEAT *typifies the way* INCO *Nickel Alloys fight metal failure. If your foe is heat, rust corrosion, wear, fatigue or stress, give the job to one of these durable alloys. They're the "task metals" of industry!*

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

INCO Nickel Alloys

Monel • "R"* Monel • "K"* Monel • "KR"* Monel • "S"* Monel Nickel • "L"* Nickel • "Z"* Nickel • Inconel* *Reg. U. S. Pat. Off.

EMBLEM OF SERVICE INCO TRADE MARK

"Task Metals" for Industry

WHAT CAN YOU DO WITH THIS?

A piece of Diamond Chain is a beautiful thing. Seeing a length of it you can scarcely resist picking it up, drawing it through your fingers, and feeling the rippling dip and fall of its matched parts. And when you do, these thoughts must occur to you:

This is a machine drive. It works as beautifully as it looks. It transmits power, on roller bearings, around the most intricate short centers and across almost any distances on machines. It cannot slip, it will not stretch, it does not absorb energy. It is compact, it takes up shock, it presents practically no problem of maintenance. . . .

Your plant can extend the use of this drive to advantage. Your salesmen can make much of such a drive on the machines you build.

Diamond Chain Engineers specialize in applying appropriate chain drives, to the end that machine sales are stimulated, and much better performance results. Have a talk with a Diamond Chain Engineer. DIAMOND CHAIN COMPANY, Inc., Dept. 435 402 Kentucky Avenue, Indianapolis 7, Indiana. *Offices and Distributors in All Principal Cities.*

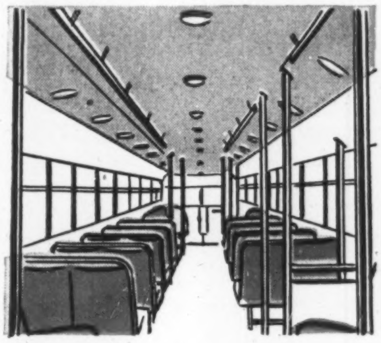
Drive Data Catalog 617 mailed on request

DIAMOND ROLLER CHAINS

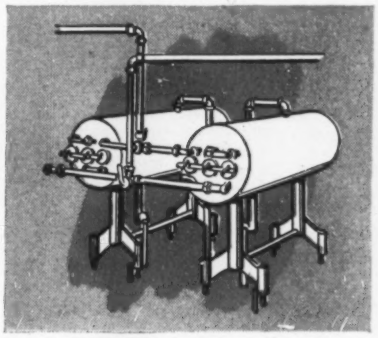
"Standard" EXCELS IN SOLVING TOUGHEST STAINLESS TUBING PROBLEMS

Bring us yours

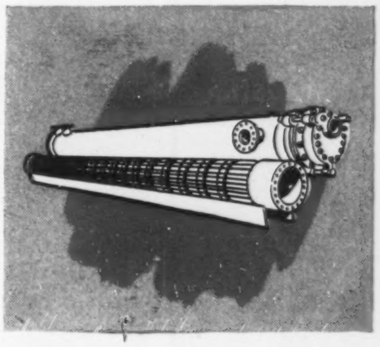
Never in 25 years has the demand for "Standard" welded steel tubing and "Standard's" unsurpassed services in licking toughest tubing problems been so great. Whether yours is a problem of fabricating—(bending, flaring, flanging, swaging, upsetting or welding)—or of selecting analyses or tolerances, "Standard" is ready to consult and assist you.



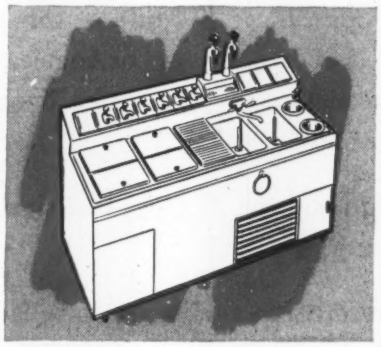
IF YOU HAVE A PROBLEM in Stainless tubing for use in bus, trolley or railroad car, consult with "Standard" experts in tubing "know-how."



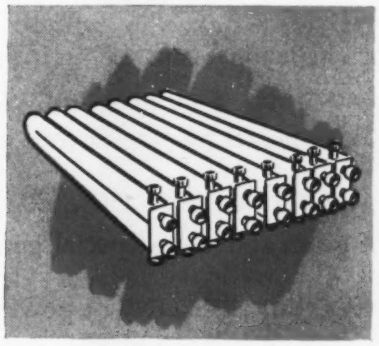
IF YOU HAVE A PROBLEM in Stainless tubing for dairy processing equipment, "Standard" can tell you the best solution for best results.



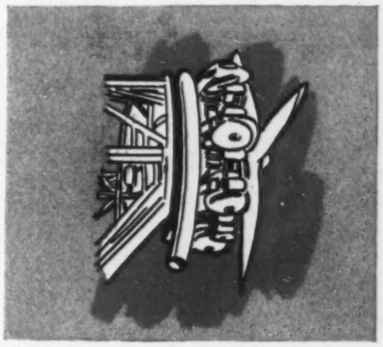
IF YOU HAVE A PROBLEM in Stainless tubing, for heat exchangers in chemical and other process plants, call on "Standard" to help you.



IF YOU HAVE A PROBLEM in Stainless tubing for use in soda fountain and beverage dispensing units, let us work out the best answer.



IF YOU HAVE A PROBLEM in Stainless tubing for use in the transmission of corrosive fluids, "Standard" is fully experienced in solving it.



IF YOU HAVE A PROBLEM in Stainless tubing in high temperature applications for aircraft and other uses, "Standard" will help you most.

"STANDARD" HAS THE EXPERIENCE AND FACILITIES TO HELP SOLVE YOUR TOUGHEST PROBLEMS PROMPTLY.

★

THE STANDARD TUBE CO.

Detroit 3, Michigan

Welded Tubing *Fabricated Parts*

STANDARDIZE with "STANDARD"—It Pays

★ Complete Tube Stocks Maintained by ★

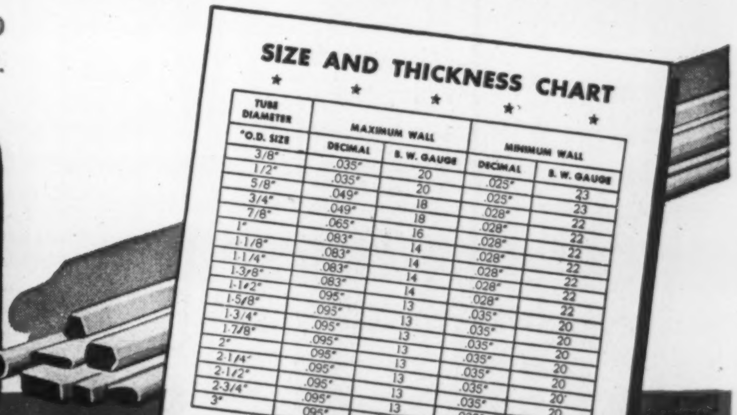
STANDARD TUBE SALES CORP., 76-01 Woodhaven Blvd., Brooklyn 27, N. Y.

LAPHAM-HICKEY COMPANY, 3333 W. 47th Place, Chicago 32, Ill.

UNION HARDWARE & METAL CO., 411 E. First St., Los Angeles 54, Cal.

THE PACIFIC PIPE COMPANY, 160 Spear St., San Francisco 5, Cal.

METAL GOODS CORPORATION, 1300 Burlington, North Kansas City, Mo.



SIZE AND THICKNESS CHART

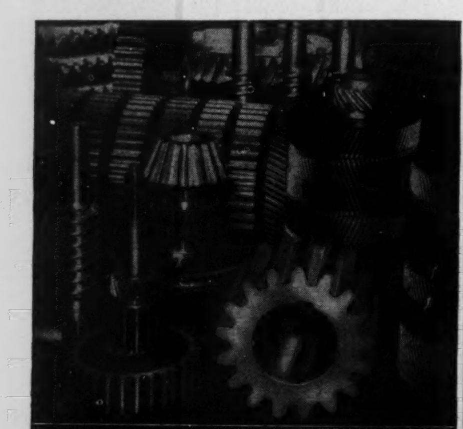
★ ★ ★ ★ ★

TUBE DIAMETER	MAXIMUM WALL		MINIMUM WALL	
*O.D. SIZE	DECIMAL	B. W. GAUGE	DECIMAL	B. W. GAUGE
3/8"	.035"	20	.025"	23
1/2"	.035"	20	.025"	23
5/8"	.049"	18	.028"	22
3/4"	.049"	18	.028"	22
7/8"	.065"	16	.028"	22
1"	.083"	14	.028"	22
1-1/8"	.083"	14	.028"	22
1-1/4"	.083"	14	.028"	22
1-3/8"	.083"	14	.028"	22
1-1/2"	.095"	13	.035"	20
1-5/8"	.095"	13	.035"	20
1-3/4"	.095"	13	.035"	20
1-7/8"	.095"	13	.035"	20
2"	.095"	13	.035"	20
2-1/4"	.095"	13	.035"	20
2-1/2"	.095"	13	.035"	20
2-3/4"	.095"	13	.035"	20
3"	.095"	13	.035"	20

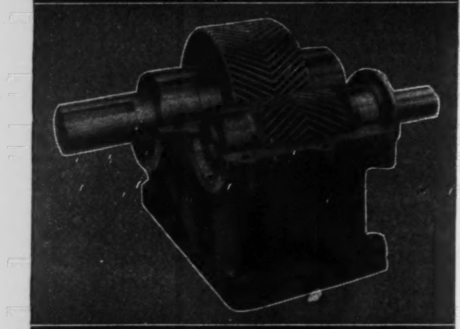
*Intermediate sizes within the range indicated can also be manufactured. Please consult us for sizes not listed.

Available in all grades of chrome nickel steels, such as types 302, 304, 316 and 347

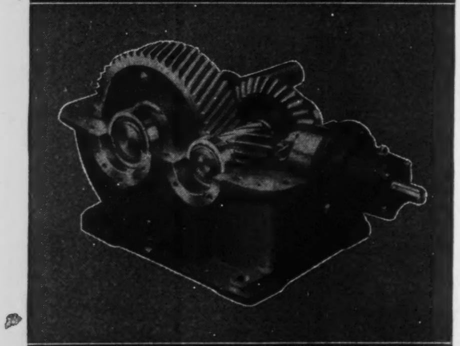
READY TO SOLVE YOUR PROBLEMS IN MACHINE DESIGN



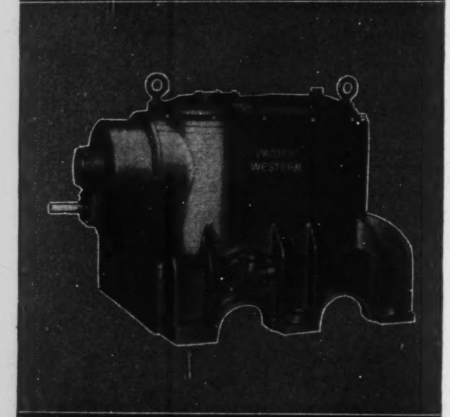
GEARS for every need



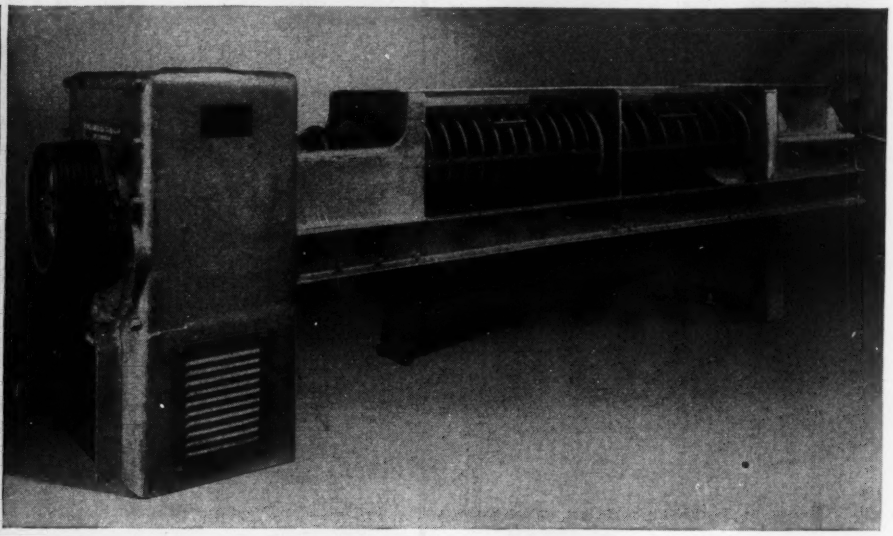
Single reduction speed reducer



Right Angle speed reducer



Vertical Speed Reducer



The photograph above shows one of several sizes of fish presses made by the California Press Manufacturing Company which for 52 years have incorporated PACIFIC-WESTERN *gears in their basic design.*

For over a half a century manufacturers having problems of machine or product design have relied upon PACIFIC-WESTERN for sound, economical solutions. Our staff of specialists are familiar with the problems of YOUR industry and are available to help YOU develop YOUR ideas. A complete mechanical power transmission service is awaiting your call at any one of three conveniently located plants in Seattle, San Francisco or Los Angeles. Remember, when planning manufacturing activities on the West Coast, it will pay you to call on PACIFIC-WESTERN.

GEARS OF ALL TYPES...We design and cut all types and sizes of gears and build special gear boxes to your requirements.

A COMPLETE LINE of power transmission equipment includes speed reducers, high speed units, Pacific-General Electric Motorized Speed Reducers, Reeves Variable Speed Equipment, couplings, Cone gears and reducers.

Fast Delivery available on many popular types and sizes of speed reducers from stock.

Write, wire or phone nearest plant or office for complete information.

WESTERN GEAR WORKS, Seattle 4, Washington
WESTERN GEAR WORKS, Box 192, Lynwood, California
PACIFIC GEAR & TOOL WORKS, San Francisco 3, California
SALES REPRESENTATIVES: Portland . . . Salt Lake City

AGMA
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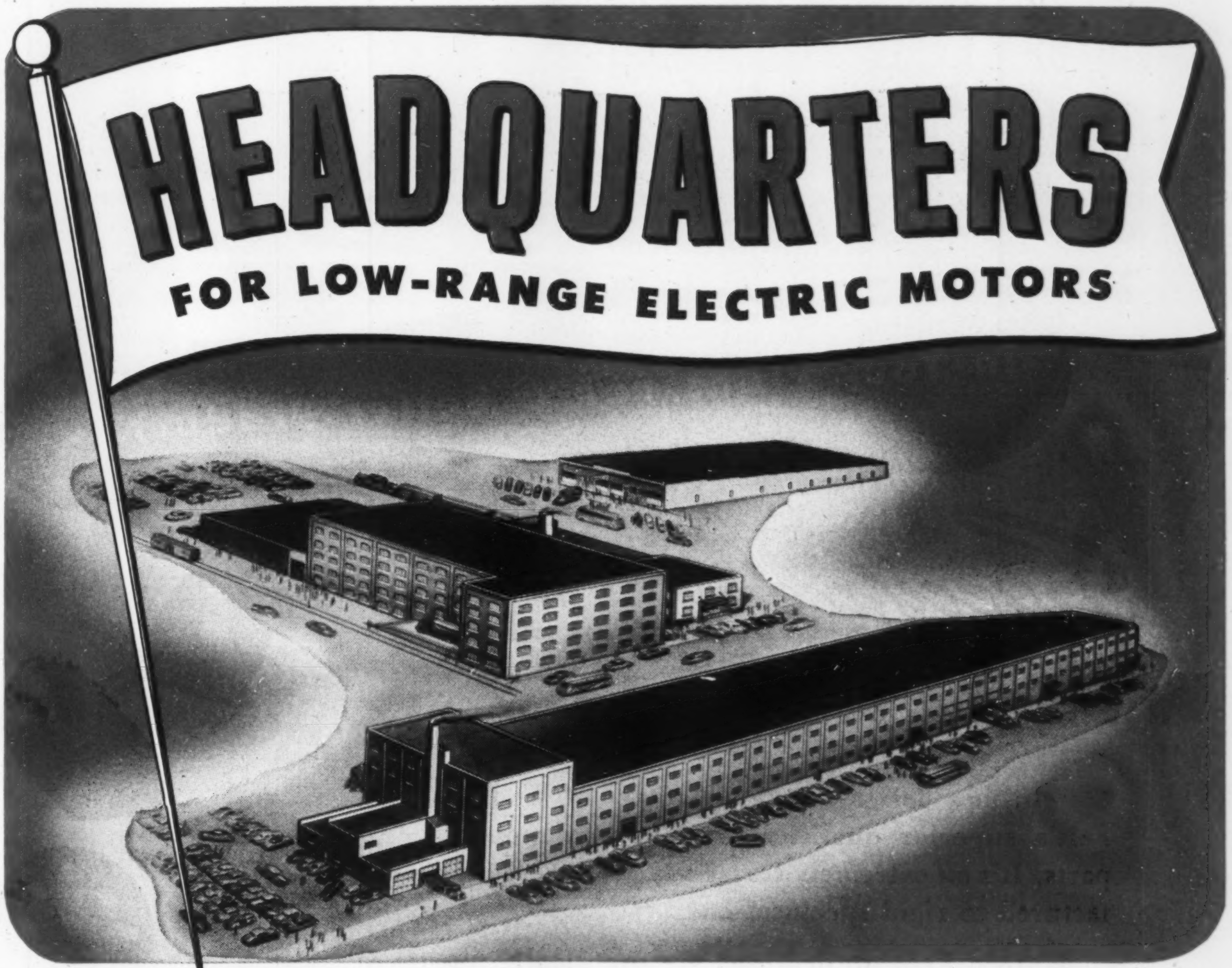
PACIFIC GEAR & TOOL WORKS — WESTERN GEAR WORKS

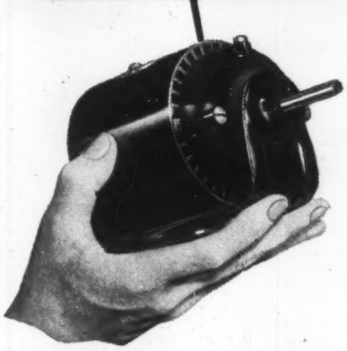
PACIFIC-WESTERN

GEAR PRODUCTS



HEADQUARTERS

FOR LOW-RANGE ELECTRIC MOTORS



Redmond...

Builder of More Than 20,000,000 MicroMotors

HERE is an organization of specialists who concentrate every effort on small electric motors and their application. Here the customer can discuss engineering details confidentially, knowing he is dealing with a motor manufacturer that does not build consumer products in competition with his own. When you need advice, contact Redmond. When you need dependable low-range fractional motors, check on the famous Redmond Micromotors.

A.C. MICROMOTORS
4-pole shaded pole up to 1/15th hp.

D.C. MICROMOTORS
Continuous duty up to 1/20th hp.
Intermittent duty up to 1/10th hp.

SPEED CONTROLLERS

SMALL BLOWERS

REDMOND

***Redmond* COMPANY, INC.** MAIN OFFICES: OWOSSO, MICHIGAN
EASTERN AREA SALES: 420 Lexington Ave., New York 17, N. Y.
PACIFIC COAST SALES: Redmond Company of Calif., Inc., 117 W. 9th St., Los Angeles 15, Calif.

In Your Plans for a Better Product . . .

Specify WESTERN *Felt*

In new designs—take advantage of Western Felt's superior qualities for many component parts. It's an extremely versatile material. Manufactured to rigid specifications.

Western Felt applications are practically unlimited—in isolating vibration, absorbing sound, filtering liquids, retaining lubricants, etc. It cuts readily to any form . . . and does not ravel, fray or lose its shape. In whatever way you may use it—Western Felt can add materially to improved performance of a product.

Name the characteristics you need . . . Western Felt engineers are ready to work with you in answering any problems that involve the possible use of felt. Write, wire or phone today.

Acadia Synthetic Division, Processors of Synthetic Rubber and Plastics: Sheets, Extrusions and Molded Parts.

WESTERN FELT WORKS

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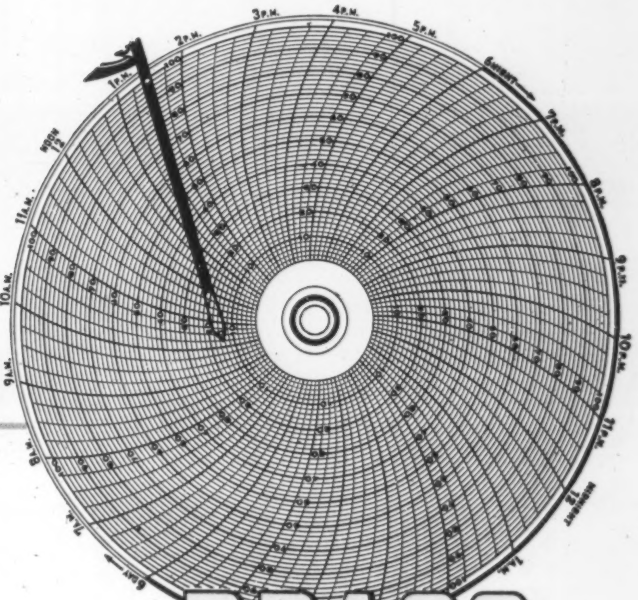
Branches in All Principal Cities

LARGEST INDEPENDENT MANUFACTURERS AND CUTTERS OF WOOL, HAIR AND JUTE FELTS

Wichita City Librar



Sustained Accuracy in instruments *so often depends on* BRASS

Ever notice the preponderance of Brass and other Copper-Alloy parts in indicating, recording and control instruments? You know the reasons: These are durable, workable, wear-resistant metals. They possess a high degree of corrosion resistance... and the ability to ward off fatigue failure caused by vibration. That means long service life.

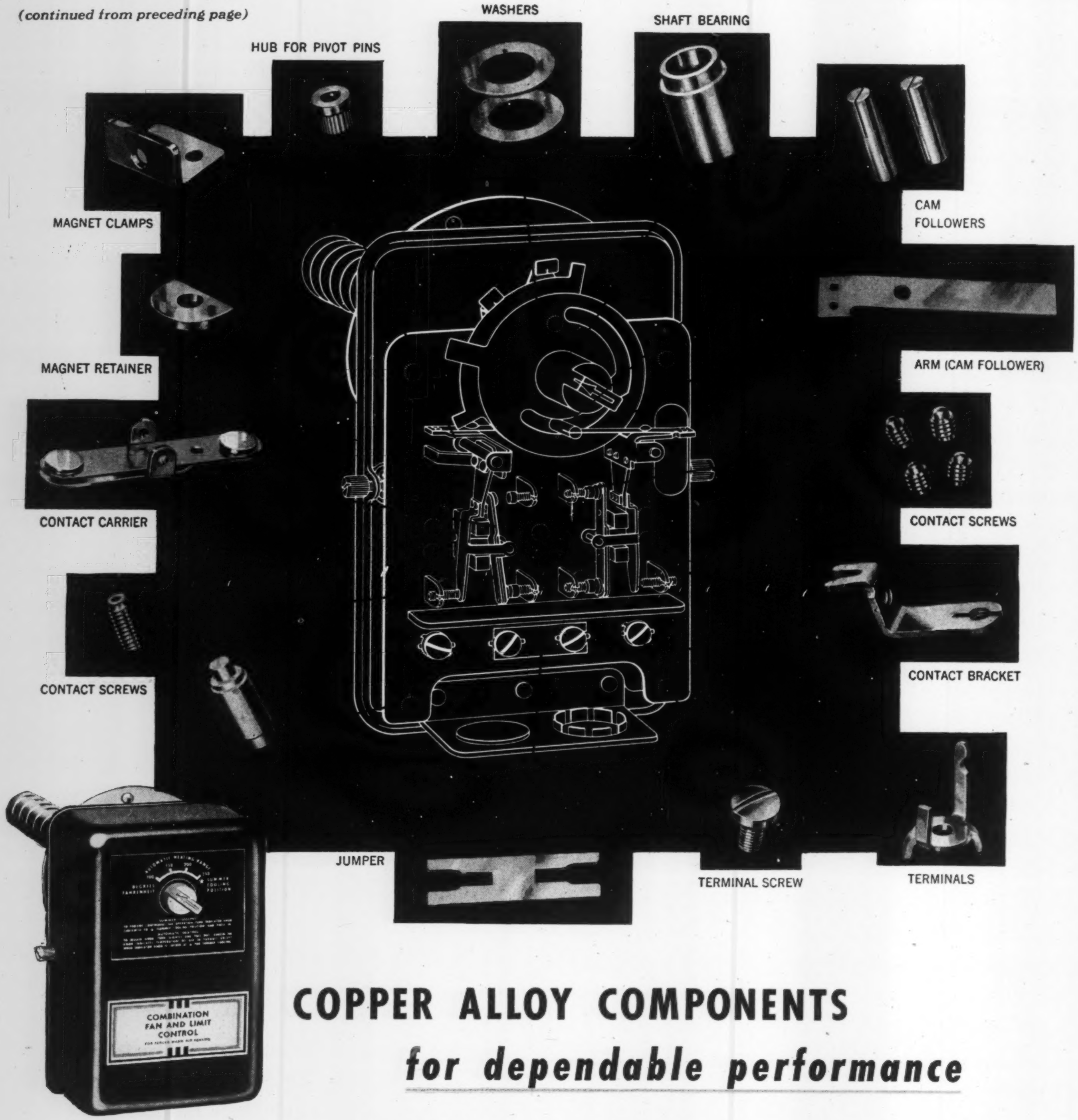
For the production of precision instrument parts, many manufacturers have found Brass to be the most dependable and economical metal to use... because *any* basic forming or machining operation that can be done on *any* metal can be done on Brass—usually faster, more accurately, and at less cost.

THE AMERICAN BRASS COMPANY
General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

Anaconda Copper Alloys

AN EXAMPLE OF COPPER-ALLOY PARTS IN INSTRUMENTS IS ILLUSTRATED ON THE FOLLOWING PAGE ➡

(continued from preceding page)


WASHERS
SHAFT BEARING
HUB FOR PIVOT PINS
MAGNET CLAMPS
CAM FOLLOWERS
MAGNET RETAINER
ARM (CAM FOLLOWER)
CONTACT CARRIER
CONTACT SCREWS
CONTACT BRACKET
CONTACT SCREWS
JUMPER
TERMINAL SCREW
TERMINALS
COMBINATION FAN AND LIMIT CONTROL

COPPER ALLOY COMPONENTS

for dependable performance

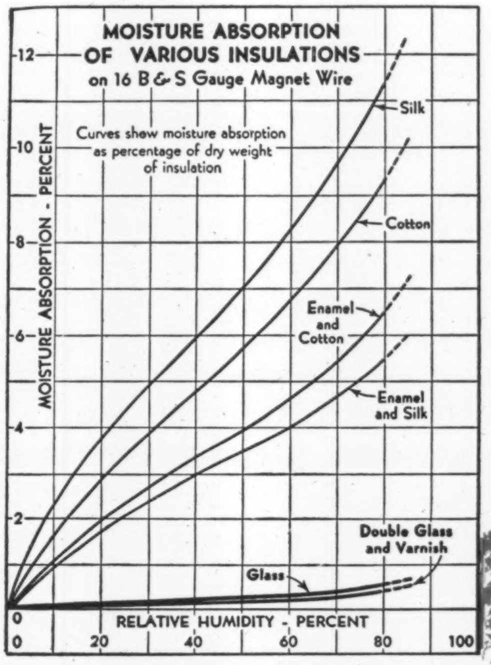
This Combination Fan and Limit Control is a Twin Contact Control manufactured by the Perfex Corporation of Milwaukee, Wisconsin. It is used in forced warm-air heating systems to protect against overheating; to improve operating efficiency; and to permit fan operation only when warm air is available. The parts illustrated above in full scale are made of Anaconda Metals which contribute, at a moderate cost, long operating life and dependable performance.

The American Brass Company has had a great deal of experience in supplying Brass and other Copper Alloys in the form, temper and grain size most suitable and economical for the production of precision instrument parts. Our Technical Department will welcome the opportunity of working with you. 47117

THE AMERICAN BRASS COMPANY
General Offices: Waterbury 88, Connecticut

ANACONDA
from mine to consumer

Anaconda Copper & Copper Alloys



IT'S GLASS INSULATED
AND MODERNLY ENGINEERED
BALDOR
ELECTRIC

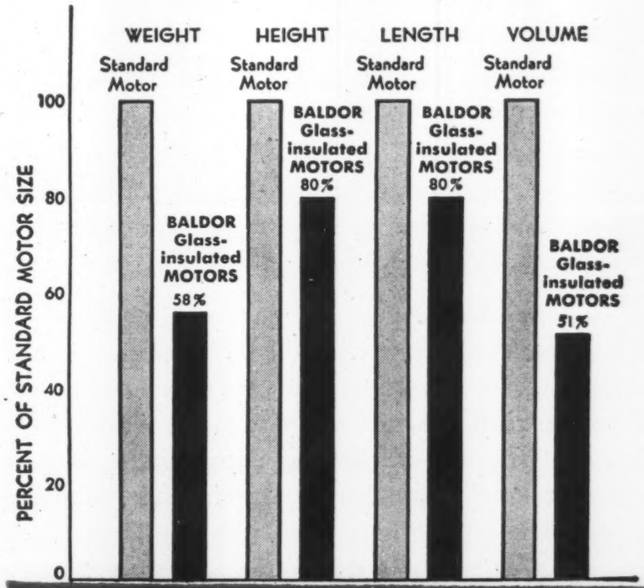
LONG, SATISFACTORY SERVICE is assured...

because glass-insulated motors withstand high ambient temperatures, are not affected by excessive moisture nor by peak loads.

These motors are more compact . . . not burdened by excessive size nor weight. They provide MORE HORSE POWER per pound of active materials, with no sacrifice of quality, efficiency nor performance.

BALDOR GLASS-INSULATED MOTORS

Compared to Size of Standard Class A Insulated Motors
10 H.P. 1800 R.P.M. - Totally Enclosed Fan Cooled



GLASS INSULATED STREAMCOOLED MOTORS

Engineered by Baldor have these important features:

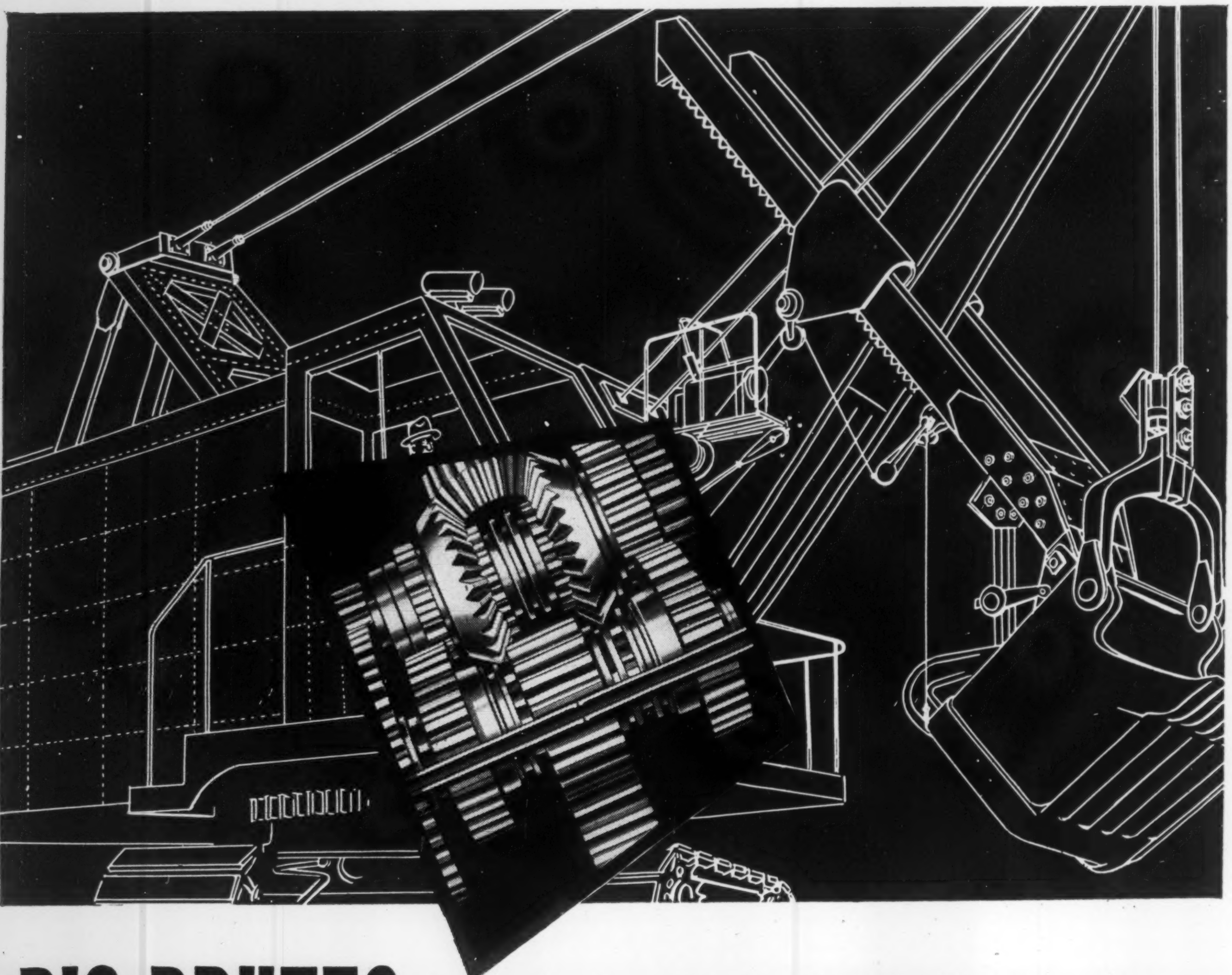
1. Totally enclosed, externally ventilated.
2. Drip-proof; splash-proof; grit-proof; lint-proof.
3. Horizontal, vertical and side-wall mounting.
4. Removable base.
5. End plates interchangeable for face mounting.

Glass-insulated motors are as modern as plastics and atomic energy, and their adoption is consistent with your modernly designed, year-ahead engineered products and equipment.

Baldor
BETTER MOTORS

ST. LOUIS
4353 DUNCAN AVE.
AND PRINCIPAL CITIES

BALDOR... *motor specialists and pioneers for more than 25 years*



BIG BRUTES "pass the buck" to FAFNIR Ball Bearings

The power shovel dipper can bite into twice its weight of rock and earth. The arm of a crane can take the ten ton strain. Heavy construction machinery can take it . . . and pass it right along to ball bearings in cable drums, gear shafts and chain drives. Fafnir Ball Bearings take it . . . the shocks, the strains, the brutal loads . . . because they roll with the punch, because they're made to take it.

Fafnir makes a complete line of medium and heavy duty ball bearings for brute service. Builders of cranes, hoists, tractors, bulldozers, power shovels and other heavy construction machinery only have to tell Fafnir the specifications to get a bearing ready-built for any load and service requirements. There are "non-filling slot" and "maximum" types with ball size, race design and variation of ball retainers in a full range of shaft diameters. From a wide choice of ingeniously designed shields and seals to retain lubricant and keep out contaminants, a manufacturer can specify bearing protection against any working conditions, anywhere, any time.

Both the makers and the users of construction machinery want ball bearings they can forget . . . bearings that take care of themselves. Construction machinery manufacturers found out more than twenty-five years ago that Fafnirs could take it. The Fafnir Bearing Company, New Britain, Conn.

MOST COMPLETE LINE IN AMERICA

FAFNIR
BALL BEARINGS

BALANCING 125 ARMATURES PER HOUR

on a Gisholt DYNETRIC Balancing Machine†*

Here's a production set-up for balancing small motor armatures for vacuum sweepers. One operator locates and measures unbalance with a Gisholt Type S Balancer and passes parts to another operator who applies the indicated correction. Parts are then returned to the Gisholt Balancer for inspection.

So efficient is this set-up that 1000 armatures are tested for unbalance, corrected and inspected in an eight-hour day—a rate of better than two a minute. Production was so increased over previous methods that the machine paid for itself in a few months.

The remarkable speed and accuracy of Gisholt DYNETRIC Balancers make it possible for you to cut costs to rock bottom. There are sizes and types to handle all rotating parts from a fraction of an ounce to many tons. Write for literature.

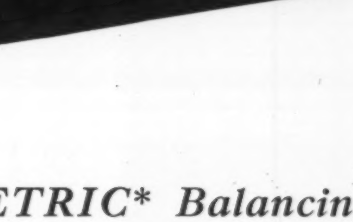
GISHOLT MACHINE COMPANY

Madison 3, Wisconsin

**Trade-mark Reg. U. S. Pat. Office by Westinghouse Electric Corporation*

†Developed jointly with Westinghouse Electric Corporation

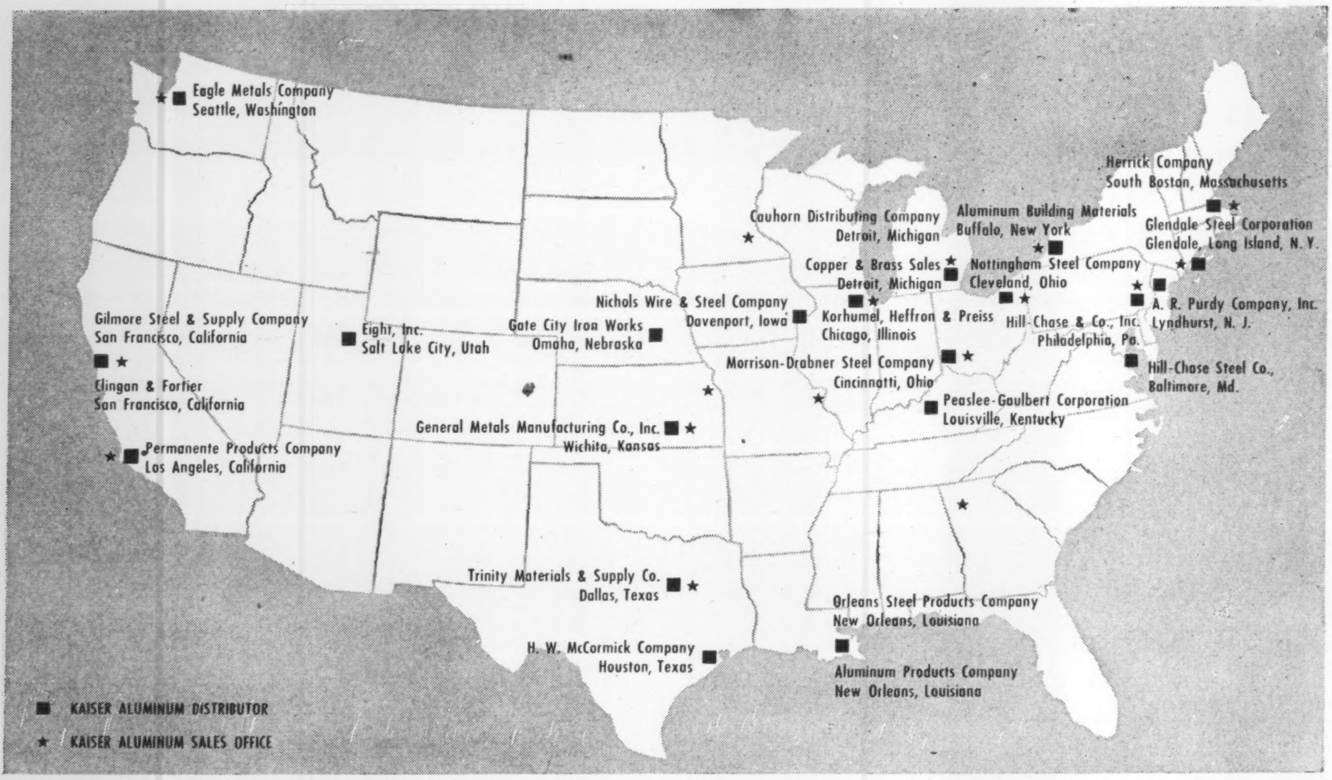
Gisholt DYNETRIC Type S Balancers *are designed for balancing parts within a weight range of a fraction of an ounce up to 200 pounds. Complete information on request.*



THE GISHOLT ROUND TABLE

represents the collective experience of specialists in the machining, surface-finishing, and balancing of round and partly round parts. Your problems are welcomed here.

TURRET LATHES • AUTOMATIC LATHES • SUPERFINISHERS • BALANCERS • SPECIAL MACHINES


Eagle Metals Company
Seattle, Washington
Gilmore Steel & Supply Company
San Francisco, California
Clingan & Fortier
San Francisco, California
Permanente Products Company
Los Angeles, California
Eight, Inc.
Salt Lake City, Utah
Gate City Iron Works
Omaha, Nebraska
Nichols Wire & Steel Company
Davenport, Iowa
General Metals Manufacturing Co., Inc.
Wichita, Kansas
Trinity Materials & Supply Co.
Dallas, Texas
H. W. McCormick Company
Houston, Texas
Cauhorn Distributing Company
Detroit, Michigan
Copper & Brass Sales
Detroit, Michigan
Korhumel, Heffron & Preiss
Chicago, Illinois
Morrison-Drabner Steel Company
Cincinnati, Ohio
Peaslee-Gaulbert Corporation
Louisville, Kentucky
Aluminum Building Materials
Buffalo, New York
Nottingham Steel Company
Cleveland, Ohio
Hill-Chase & Co., Inc.
Philadelphia, Pa.
Hill-Chase Steel Co.,
Baltimore, Md.
A. R. Purdy Company, Inc.
Lyndhurst, N. J.
Glendale Steel Corporation
Glendale, Long Island, N. Y.
Herrick Company
South Boston, Massachusetts
Orleans Steel Products Company
New Orleans, Louisiana
Aluminum Products Company
New Orleans, Louisiana
■ KAISER ALUMINUM DISTRIBUTOR
★ KAISER ALUMINUM SALES OFFICE

Here are your new supply points for Kaiser Aluminum

23 CONVENIENTLY LOCATED DISTRIBUTORS OFFER KAISER ALUMINUM SHEET, PLATE, STRIP, COIL, CIRCLES, ROOFING AND SIDING . . . IN LESS THAN CARLOAD LOTS

Now you can be certain of a close-up source of Kaiser Aluminum . . . *wherever you are located.*

Permanente Products Company is proud to announce the appointment of 23 of the finest material supply houses in the country as distributors of Kaiser Aluminum.

Your local distributor offers complete warehouse stocks of Kaiser Aluminum to meet your immediate needs. No longer need you wait for small carry-over stocks . . . for your local distributor sells in less than carload lots!

This new nationwide network of distributors is in addition, of course, to Permanente Products' 19 sales offices, each ready to help you in solving your engineering problems.

Which means that Permanente Products . . . in only a little over a year of operation . . . now completely rounds out its service facilities . . . to bring you more and better aluminum—*faster!*

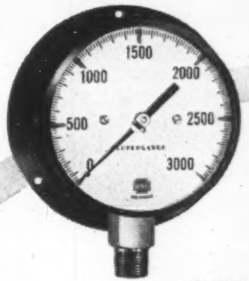
Ready to serve you—today . . . 23 conveniently located

Kaiser Aluminum Distributors

PERMANENTE PRODUCTS COMPANY, KAISER BUILDING, OAKLAND 12, CALIFORNIA . . . WITH OFFICES IN:
Seattle • Oakland • Los Angeles • Dallas • Wichita • Kansas City • St. Louis • Atlanta • Minneapolis • Milwaukee • Chicago
Cincinnati • Cleveland • Detroit • Boston • Buffalo • New York City • Philadelphia • Washington, D. C.

USG HELPS YOU SELECT GAUGES

From the World's Largest Family of Instruments

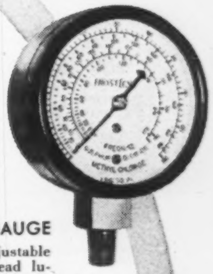


SUPERGAUGE

An instrument of test gauge accuracy, designed for many years of service in heavy-duty industrial installations. Withstands excessive vibration and pulsation and provides a safe positive check on process control.

ULTRAGAUGE

A superior quality gauge of top-most accuracy and durability, designed especially for chemical and oil refinery applications. Furnished in 4½", 6", 8½", 12" and 16" dial sizes . . . from vacuum up to 100,000 pounds per square inch pressures.

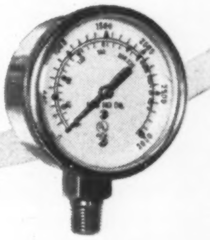


REFRIGERATION GAUGE

Important features include: adjustable hub pointer, broad easy-to-read luminous dial, removable screw check. Low side gauge has 1" and 1 lb. graduation and is protected to 200 lbs. overpressure. Also available with external calibrator and retarded movement.

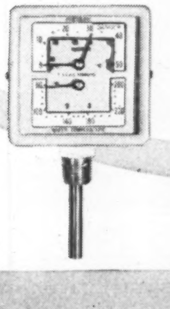
HYDRAULIC GAUGE

A gauge built to give continuing and accurate measurement of hydraulic pressures. The extra heavy-duty movement is designed to withstand the severe shocks and rugged service required of gauges when installed on hydraulic presses and Diesel engines.



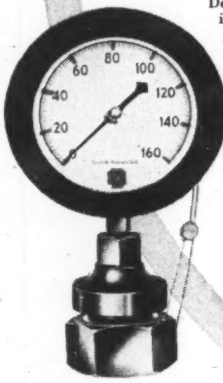
WELDING GAUGE

This well designed gauge incorporates the safety blowout features in the low as well as the high pressures. It is especially designed to withstand rugged handling. It is a tough gauge for a tough job.



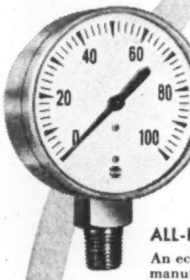
BOILER GAUGE

For use on hot water heating systems. Indicates on one dial: water temperature, head of water above gauge and pressure in system. Rugged construction with easy-to-read dial. Available in round or square case.



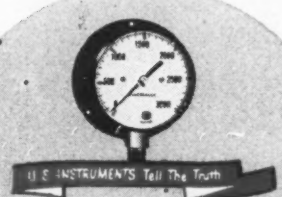
CHEMICAL GAUGE
Clean-Out Type

Designed for service in chemical and processing plants for use on heavy viscous fluids that tend to clog. Supplied with precious metal diaphragms and assemblies for highly corrosive chemical application. Diaphragm is easily removed for cleaning.



ALL-PURPOSE PRESSURE GAUGE

An economically priced pressure gauge manufactured to commercial accuracy. It has a phosphor bronze bourdon tube and a corrosion-resistant movement. It's smart in appearance and dependable in performance.



6 out of 10 Manufacturers Buy US Gauges

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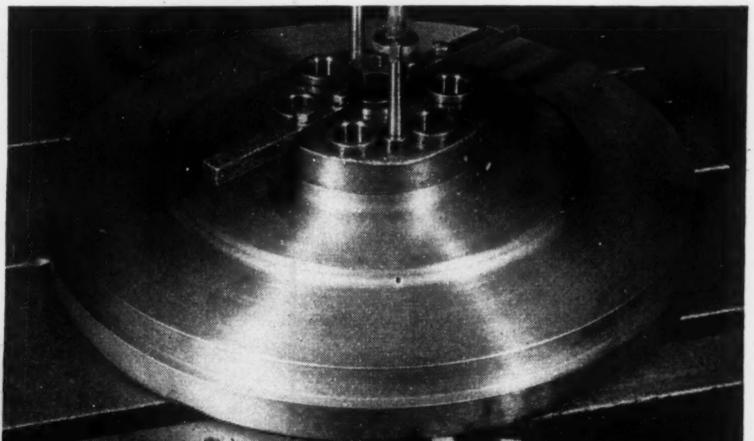
*Mr.*________________ *Title*____________

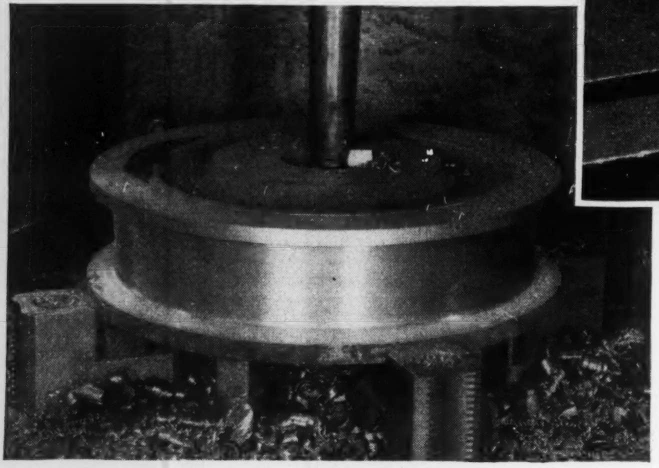
*Company*________________________

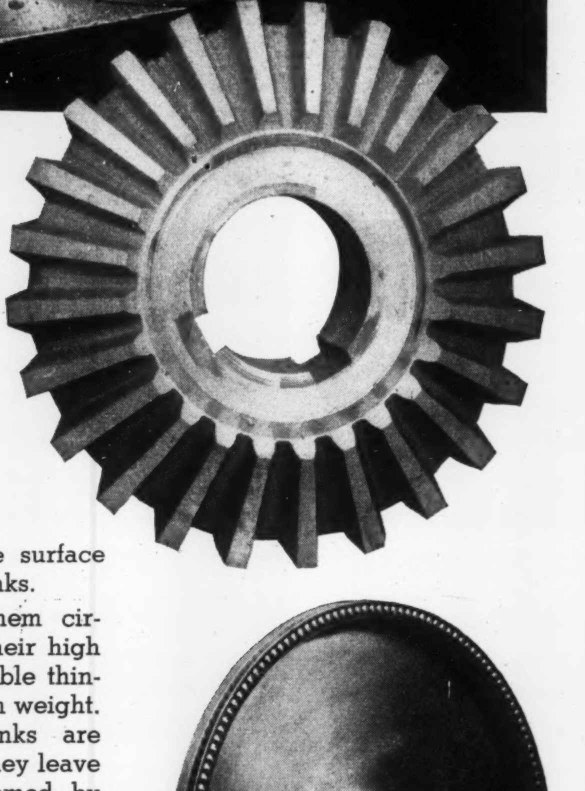
*Address*________________________

*City*________________ *State*____________

"We tried 'em...We like 'em"







Shown here are some typical products made from Bethlehem's rolled-and-forged circular blanks. *Above,* crane-track wheel and flywheel; *right,* bevel gear and turbine rotor.

The man is talking about Bethlehem circular forgings. Could be he's you. In any event, he represents the many designers and production men who know the advantages of these sturdy money-saving products.

For makers of finished gears, crane-track wheels, turbine rotors, sheaves, flywheels, tire molds, and numerous other circular items, Bethlehem's forged-steel blanks are both practical and economical. They are not made by conventional forging and rolling, but by a process that combines these steps in one unique machine. It is a carefully-worked-out method that imparts homogeneity, excellent physical properties, and fine surface characteristics to the blanks.

Designers like Bethlehem circular forgings because their high quality often makes possible thinner sections . . . savings in weight. And, because the blanks are rough-machined before they leave our plant, they're welcomed by the production men. Bethlehem's rough-machining, of course, saves a plant operation for the customer.

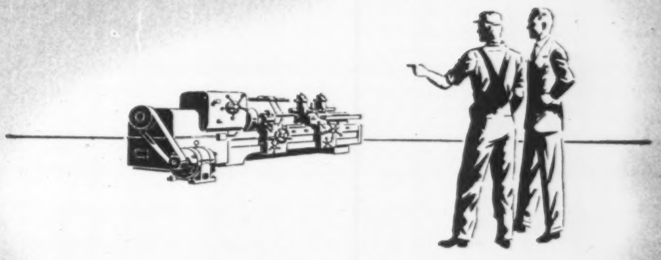
We can supply these blanks in carbon or alloy steel, treated or untreated. Sizes range from approximately 10 to 44 in. OD. More details—and there are many of interest—will be cheerfully furnished at your request.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by
Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

Ask your repairman what he thinks of Crocker-Wheeler **protected-type** motors



Here is an easy test of motor quality: Ask the man who has to keep your motors in running order.

You will find that the repairman has a very high regard for Crocker-Wheeler motors BECAUSE *he has had so few of them to repair.*

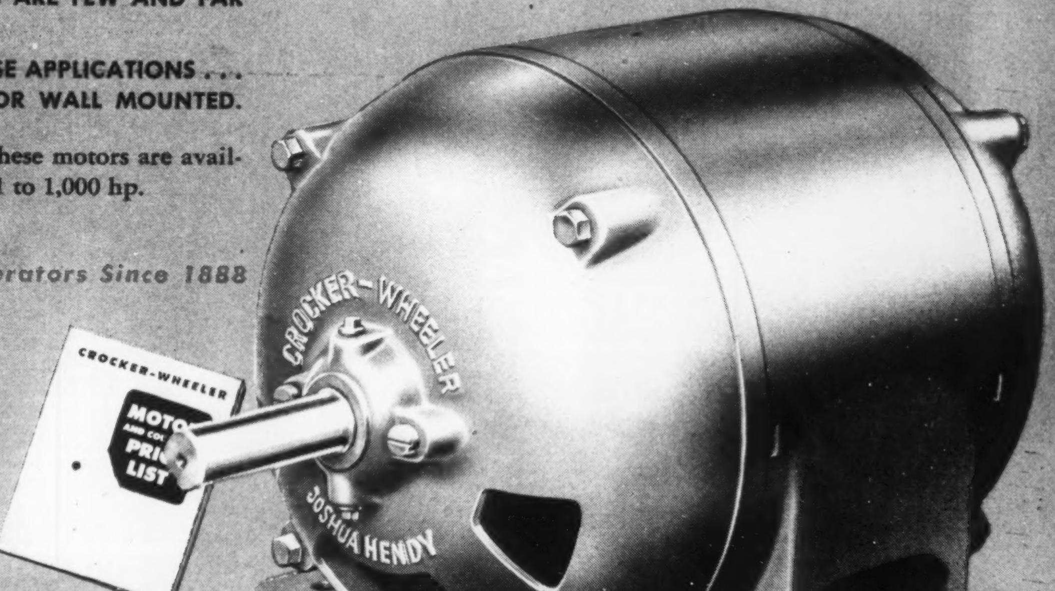
Crocker-Wheeler Protected-Type motors are recommended for use–

- **WHERE THERE IS DRIPPING LIQUID**
- **WHERE THERE ARE FALLING CHIPS**
- **WHEN INSPECTION VISITS ARE FEW AND FAR BETWEEN**
- **FOR ALL GENERAL PURPOSE APPLICATIONS . . . HORIZONTAL, VERTICAL OR WALL MOUNTED.**

Designed for the tough jobs, these motors are available in standard ratings, from 1 to 1,000 hp.

Ask for full information.

Quality Motors and Generators Since 1888



TAKE THE HEADACHE OUT OF BUYING AND SPECIFYING MOTORS

Ask for your FREE copy of this new 8-page price list. Gives prices, weights, dimensions of all the most commonly used motors, in standard ratings up to 75 hp:

SQUIRREL-CAGE MOTORS: *Protected-Type, Totally Enclosed Non-Ventilated, Totally-Enclosed Fan-Cooled, Explosion-Proof, Splashproof;* **WOUND-ROTOR MOTORS; DIRECT-CURRENT MOTORS:** *Constant-Speed, Adjustable-Speed.*

Also includes additions for bases, flexible couplings and control. Send for your copy today.

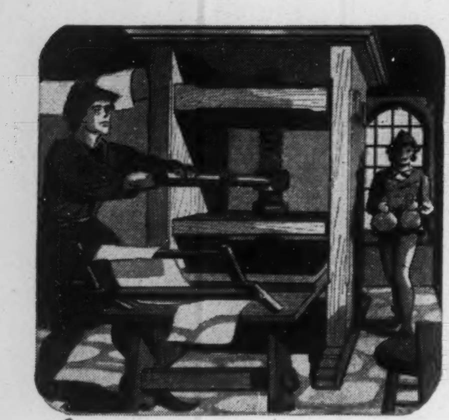
CW-21

CROCKER WHEELER

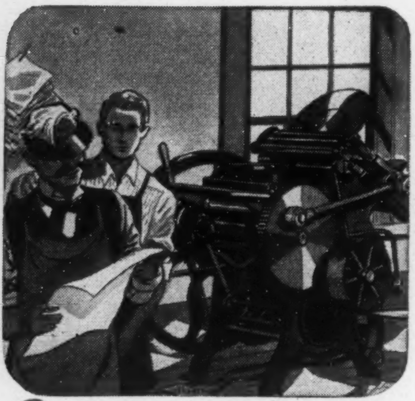
ELECTRIC MANUFACTURING COMPANY, AMPERE, N. J.

A Division of Joshua Hendy Corporation

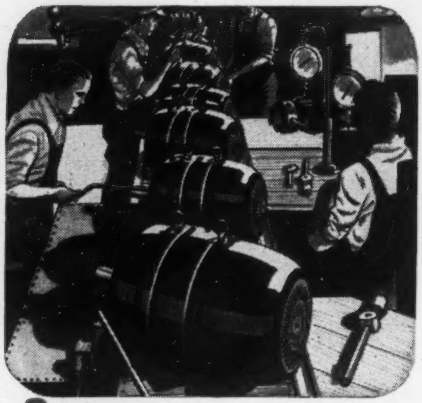
Branch Offices: Boston, Chicago, Cincinnati, Cleveland, Los Angeles, New York, Philadelphia, Pittsburgh — Representatives in Principal Cities.



1 **1450**—First printing presses stemmed from cheese or cider presses. Gutenberg's hand press used type carved from wood and metal. Four centuries later printing was still largely a manual operation. But the Industrial Revolution was near.

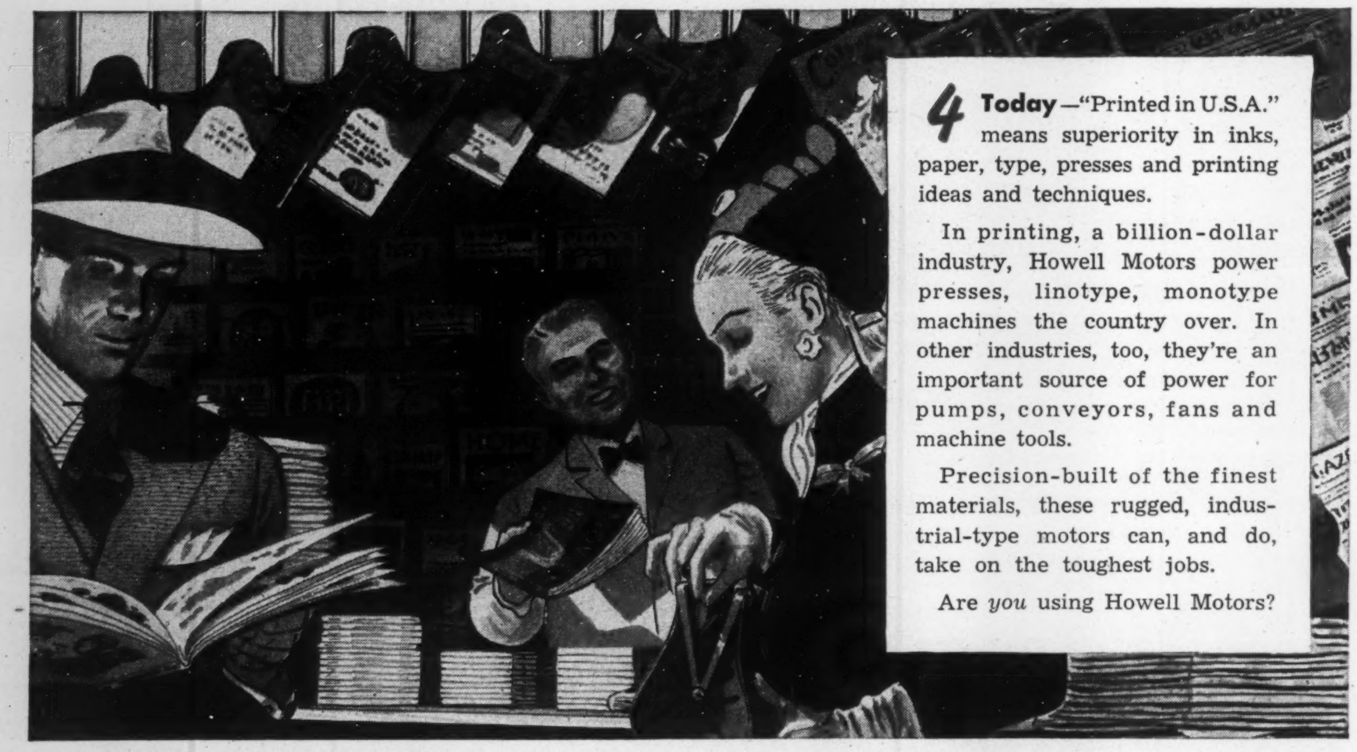


2 **1875-95**—Electric power revolutionized printing. Hand work gave way to powered presses and machines. Foot treadles and hand cranks disappeared. Low cost electricity started printing on its way to becoming a modern art.



3 **1930**—Whereas, Gutenberg was 7 years printing 200 copies of his Bible—presses of the thirties did the job in 20 minutes! In 1915 Howell "Red Band" motors were introduced. They won instant acclaim in this and other industries.

"Printed in U. S. A."—and how!



4 **Today**—"Printed in U.S.A." means superiority in inks, paper, type, presses and printing ideas and techniques.

In printing, a billion-dollar industry, Howell Motors power presses, linotype, monotype machines the country over. In other industries, too, they're an important source of power for pumps, conveyors, fans and machine tools.

Precision-built of the finest materials, these rugged, industrial-type motors can, and do, take on the toughest jobs.

Are *you* using Howell Motors?

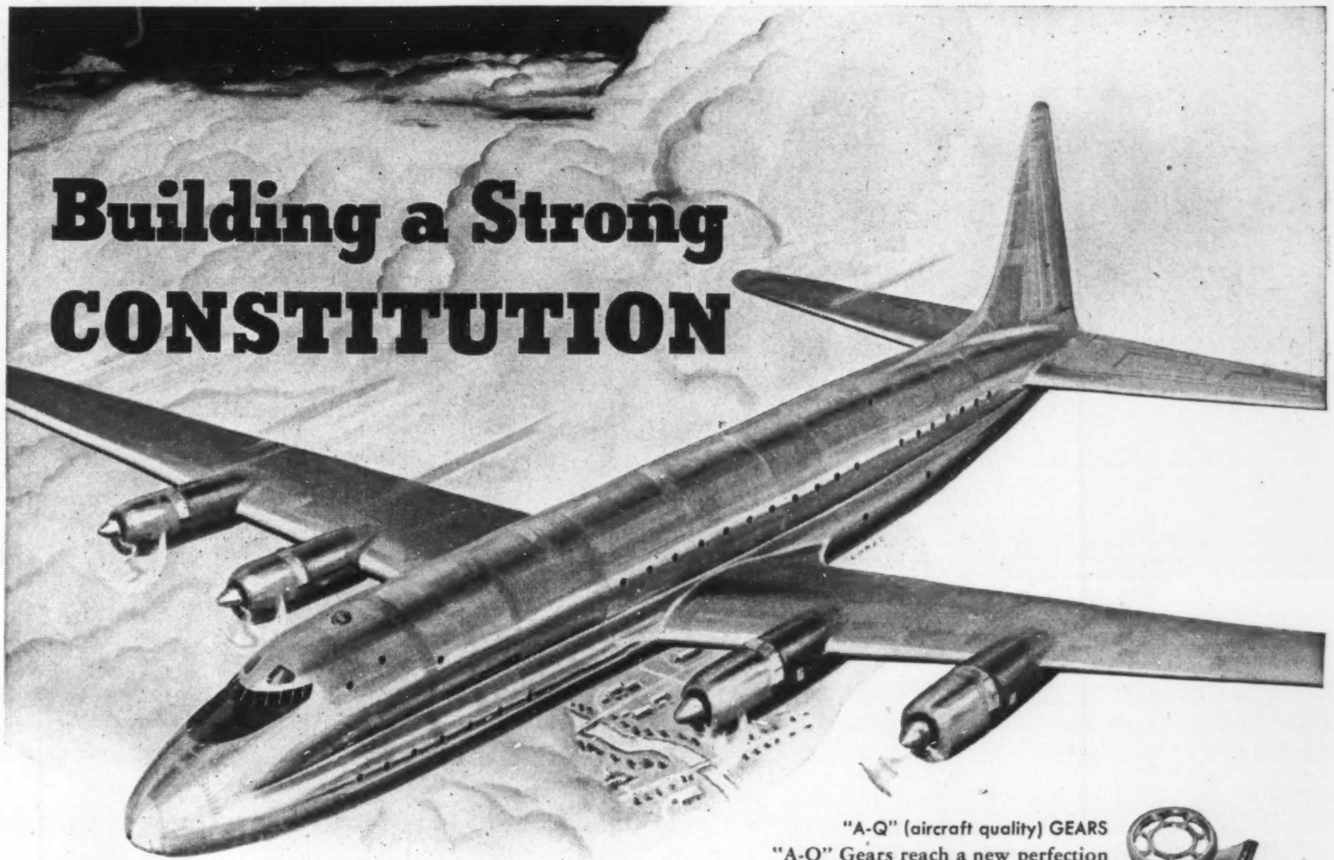
Here's another precision-built Howell Motor . . . industrial type with copper or bronze rotors . . . specially insulated . . . statically and dynamically balanced.

The Howell Protected Type Motors

HOWELL MOTORS

HOWELL ELECTRIC MOTORS CO., HOWELL, MICH.

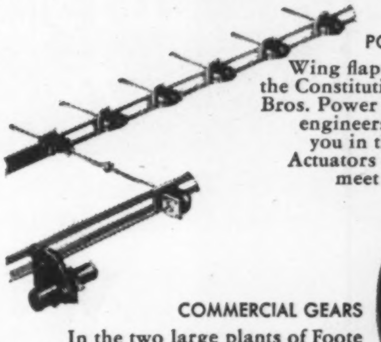
Manufacturers of Quality Industrial Type Motors Since 1915



Building a Strong CONSTITUTION

"A-Q" (aircraft quality) GEARS

"A-Q" Gears reach a new perfection in accuracy which permits excessive speeds, high load capacity, minimum weight, increased efficiency and low noise level. If you require better gears, discuss your needs with Foote Bros. engineers.

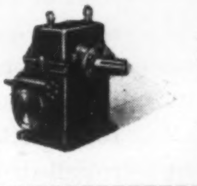


POWER UNITS

Wing flap control system on the Constitution showing Foote Bros. Power Units. Foote Bros. engineers will gladly assist you in the development of Actuators or Power Units to meet any requirements.

COMMERCIAL GEARS

In the two large plants of Foote Bros. are complete facilities for producing quality gears in quantity. If you require helical, spur, worm or bevel gears, call on Foote Bros.



SPEED REDUCERS

Nearly a century of manufacturing experience is back of Foote Bros. speed reducers—available in sizes and ratios to meet practically any speed reduction problem. Helical reducers in single, double and triple reduction types. Worm reducers in single and double reduction.

On such mighty airliners of tomorrow as the giant Lockheed Constitution, Foote Bros. Power Units and Foote Bros "A-Q" (aircraft quality) Gears are helping to solve engineering problems encountered by the designers.

The operation of this ship demonstrates the effective method of control by specially engineered Actuators and Power Units produced by Foote Bros.

In the Pratt and Whitney engines that power the Constitution are Foote Bros. "A-Q" Gears—gears that achieve a perfection considered impossible a few years ago.

Foote Bros. Power Units and Actuators offer a practical method of controlling linear and rotary motion within an exacting time cycle and within a confined space envelope. Whether you manufacture airplanes or road construction machinery—printing presses or other mechanical equipment, these units may offer your engineers ideas on better methods of power control.

For any power transmission application requiring high speed, greater efficiency, light weight, compactness and low noise level, Foote Bros. "A-Q" Gears open up new possibilities in design.

Foote Bros. engineers stand ready to assist in the development of gears and control devices to solve the problems with which you are faced.

FOOTE BROS. GEAR AND MACHINE CORPORATION
Dept. O, 4545 South Western Boulevard • Chicago 9, Ill.

FOOTE BROS.
Better Power Transmission Through Better Gears

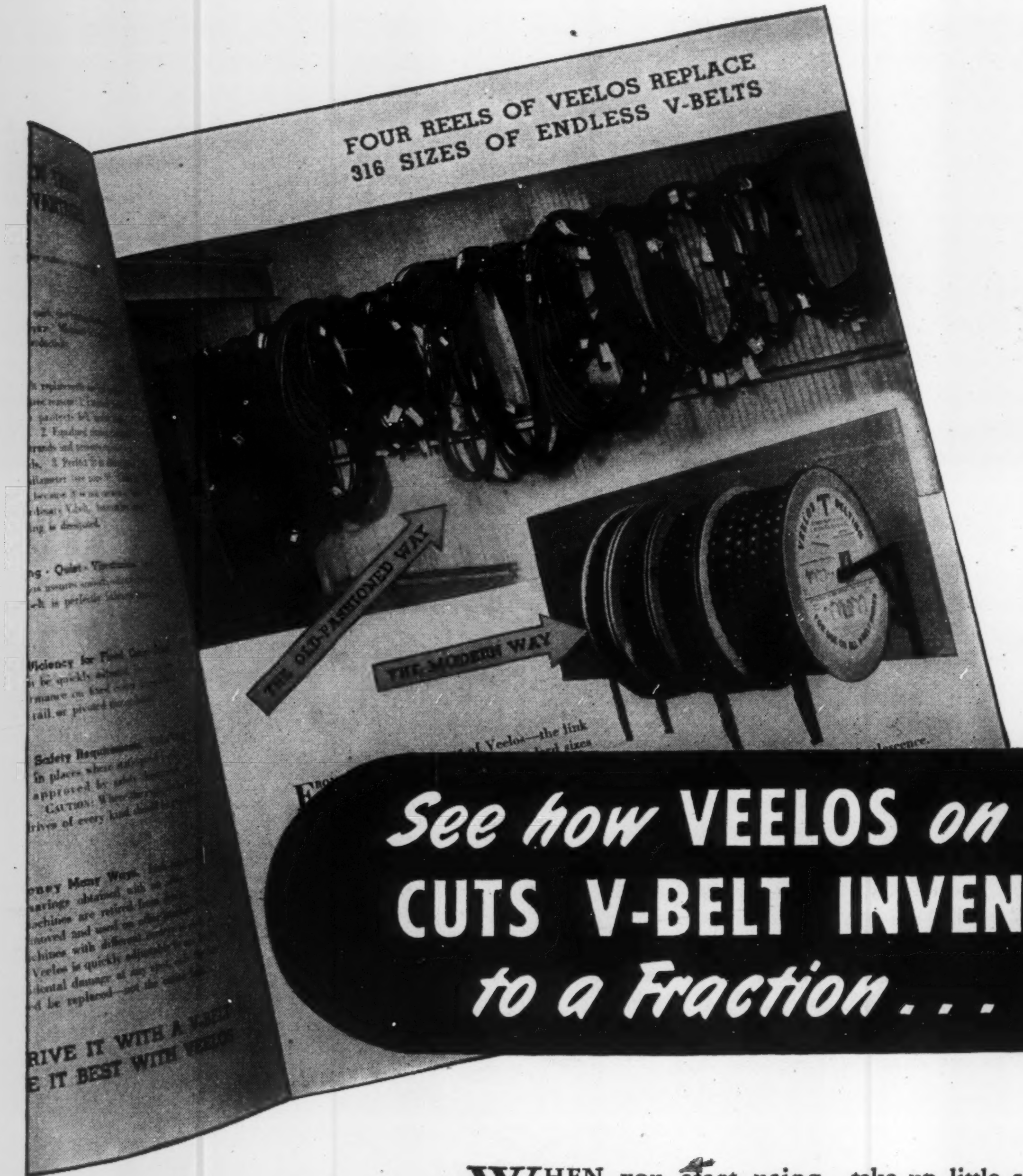
Three bulletins on Foote Bros. products are available. Check the coupon for the ones you are interested in.

☐ FOLDER "WHATEVER YOUR NEEDS IN GEARS"
☐ BULLETIN "AIRCRAFT QUALITY GEARS"
☐ BULLETIN "FOOTE BROS. POWER UNITS"

Name..

Address..

City.................................... *State*..........



Page 3—
New Veelos Catalog

See how VEELOS *on Reels* CUTS V-BELT INVENTORY *to a Fraction . . .*

Tested, Proved and Adopted by American Industry

WHEN you start using Veelos, the link V-belt, you stop buying spare sets of belts for each drive. You just don't need them. With only 4 reels of Veelos you can replace as many as 316 sizes of endless V-belts. Any length belt for any drive is easily uncoupled from a reel, quickly made endless and installed. Never again will you see an unused V-belt deteriorating in stock. Reels of Veelos take up little storage space . . . simplify stock records.

These are just a few of the many outstanding advantages of Veelos on reels explained in the new Veelos catalog. You'll also learn why Veelos costs far less to install, cuts machine down-time, ends the woes of endless V-belts. *Send for your free copy right away.*

MANHEIM MANUFACTURING & BELTING COMPANY
MANHEIM, PENNSYLVANIA

VEELOS
THE LINK
V-BELT

Adjustable to any Length
Adaptable to any Drive

Known as VEELINK outside the United States

Bellows Assemblies May Solve Your Problem

More and more designers are taking advantage of the great versatility of bellows assemblies, specifying them in increasingly wide fields of application. Here are some of the functions bellows assemblies are designed to perform efficiently and economically:

- Actuate switches or valves by direct or remote control.
- Seal rotary shafts against leakage of liquid or gas.
- Transmit movement hydraulically to remote points.
- Provide a flexible joint for instruments combining rotary motion and hermetic seal.
- Compensate for changes in temperature or pressure.
- Seal valves against leakage (packless valves).

INVESTIGATE HYDRON BELLOWS ASSEMBLIES

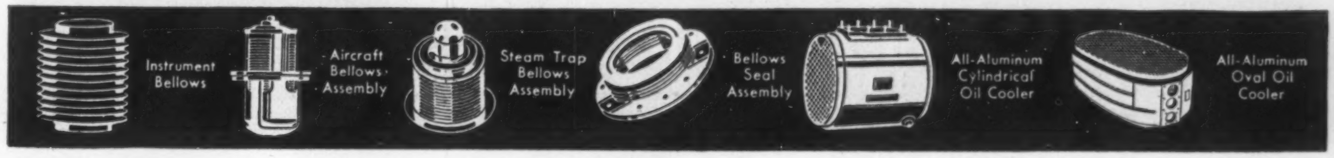
If your problem involves these or similar functions, our engineering department will design a bellows assembly for your specific requirements. Send sketches and specifications. CLIFFORD MANUFACTURING COMPANY, 566 E. FIRST ST., BOSTON 27, MASS. Offices in Detroit, Chicago and Los Angeles. *First with the Facts on Hydraulically-Formed Bellows.*

CLIFFORD HYDRON Metal Bellows

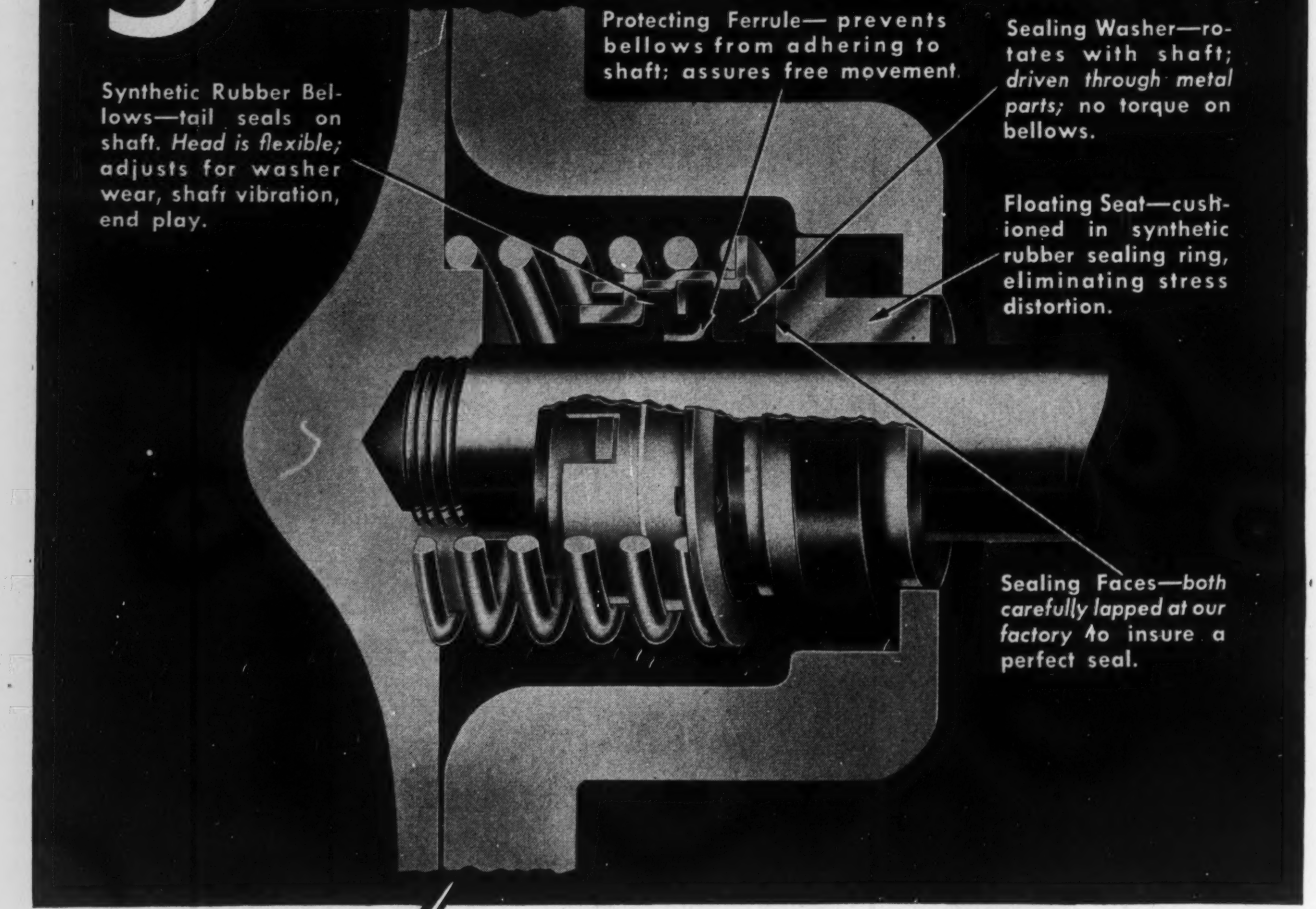
HYDRAULICALLY-FORMED BELLOWS

ALL-ALUMINUM OIL COOLERS

Feather Weight


Instrument Bellows
Aircraft Bellows Assembly
Steam Trap Bellows Assembly
Bellows Seal Assembly
All-Aluminum Cylindrical Oil Cooler
All-Aluminum Oval Oil Cooler

5 OUTSTANDING *Features*


Protecting Ferrule— prevents bellows from adhering to shaft; assures free movement.
Sealing Washer—rotates with shaft; *driven through metal parts;* no torque on bellows.
Synthetic Rubber Bellows—tail seals on shaft. *Head is flexible;* adjusts for washer wear, shaft vibration, end play.
Floating Seat—cushioned in synthetic rubber sealing ring, eliminating stress distortion.
Sealing Faces—*both carefully lapped at our factory to* insure a perfect seal.

of the JOHN CRANE
BELLOWS-TYPE *Shaft Seal*

This is a new, precision-built Shaft Seal already thoroughly proven on Centrifugal and Rotary Pumps, Speed Reducers, Refrigeration Compressors, Agitator Shafts and many other rotating shaft sealing applications.

Advantages:

- ***Eliminates leakage, gland adjustment and shaft wear***
- ***Reduces friction, saves power***
- ***Operates effectively at high speeds and pressures***
- ***Shipped as a complete unit, ready for installation***

The John Crane Bellows-Type Shaft Seal is made in two types: Type 1 for limited diameter; Type 11 (illustrated above) for limited length.

Design and Development Engineers—Send for Illustrated Bulletin

CRANE PACKING COMPANY

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CRANE PACKING CO., LTD., Hamilton, Ontario, Canada.
Branches: Montreal, Toronto, Vancouver

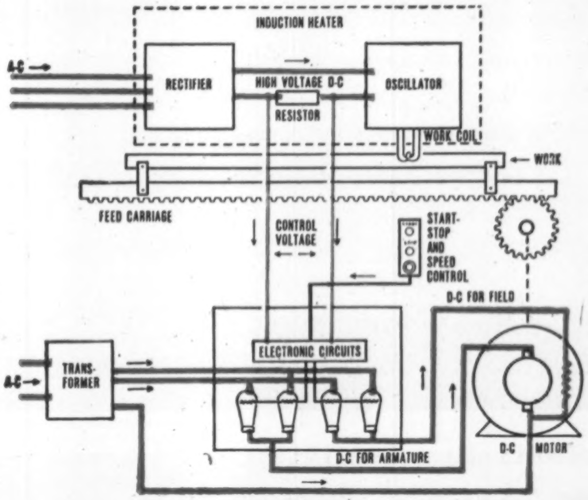
AUTOMATIC
ELECTRONIC
FEED DRIVE

...brings new precision to continuous induction heating!

G-E Thy-mo-trol matches feed drive speed with heater performance to maintain more uniform quality.

Automatic speed matching with G-E Thy-mo-trol drive continues to make news for machine designers! First, it was matching the rate of feed with the depth of cut on a milling machine. Then, it was keeping conveyor speeds in step with the output of an extruding machine.

AND NOW . . . it's been put to work on an electronic induction heater, maintaining tight quality control! All of this proves a point—where precise, automatic speed matching is required, Thy-mo-trol drive is a wise choice.



Control of this induction heater's feed drive is correlated with the amount of load placed on the heater work coil. Changes in the current of the heater oscillator are reflected as voltage change across a resistor connected in the heater circuit. This voltage adjusts the speed of the motor by controlling the thyratron tubes in the Thy-mo-trol panel. Thus, the speed of the feed motor almost instantaneously follows variations in the load current.

GENERAL ELECTRIC

676-195-8910

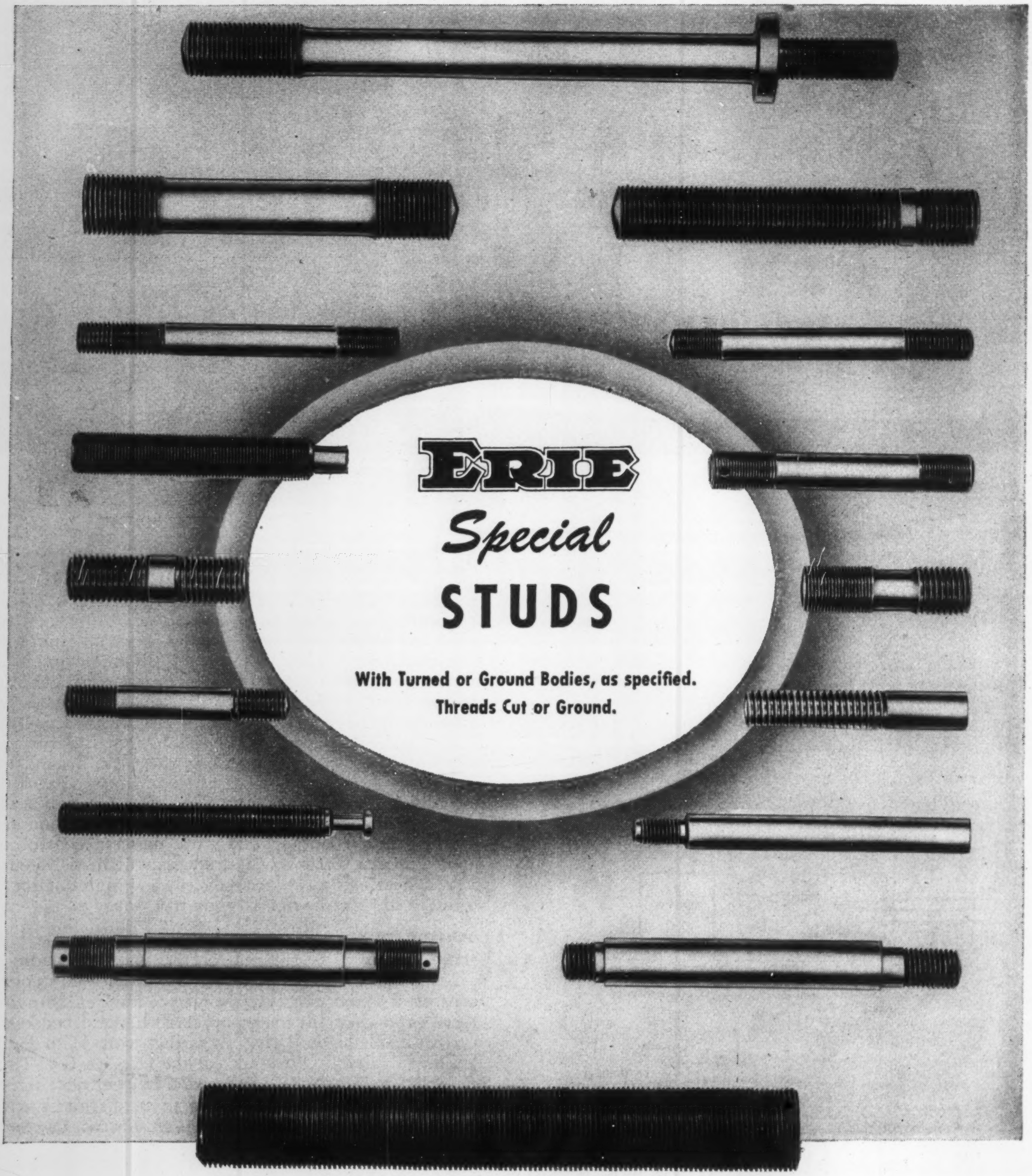
INDUCTION HEATER IS PROOF!

On continuous induction heating, the ability to vary the travel speed is very important in producing uniform heat treatment of parts. Best results can not be obtained with a constant feed rate, because in order to get the desired depth of heat penetration, the speed must be varied as the size of the part varies. Some way of readily adapting the feed speed to the size of part is needed—and Thy-mo-trol drive provides the ideal way. The Thy-mo-trol circuit is connected to the load circuit of the induction heater. In this way, Thy-mo-trol automatically changes the speed of the carriage to maintain constant power output, and thus, uniform control of hardened area. Parts move at speeds which will assure correct heating, rejects are reduced, and high-quality is maintained—because of Thy-mo-trol drive.

INVESTIGATE THY-MO-TROL DRIVE NOW!

Speed matching is but one of the many functions a Thy-mo-trol drive can perform. Some others are stepless control of speed over a wide range; holding constant speed under changing loads; and smooth, rapid, constant-current acceleration. Drives in ratings from 1/8 to 25 hp are now available. Why not get the facts on G-E Thy-mo-trol before you make a decision on your next drive? Your local G-E office will be glad to discuss it with you. *Apparatus Department, General Electric Company, Schenectady* 5, *N. Y.*

THY-MO-TROL DRIVE



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Operating!

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Dimenso is the *only* finishing material that will give you such realistic hammered, toned hammered, or diffused finishes in one easy operation! Through the nozzle of patented gun you can coat metal and plastics with 2-color, 3-dimensional finishes of surpassing beauty. Have our representative call, or send for . . .

FREE DIMENSO BOOKLET — a request on your letterhead will bring descriptive booklet . . . actual finish samples. The Sherwin-Williams Co., Cleveland 1, Ohio.

PRODUCT OF *SHERWIN-WILLIAMS* INDUSTRIAL RESEARCH

SHERWIN-WILLIAMS
INDUSTRIAL FINISHES

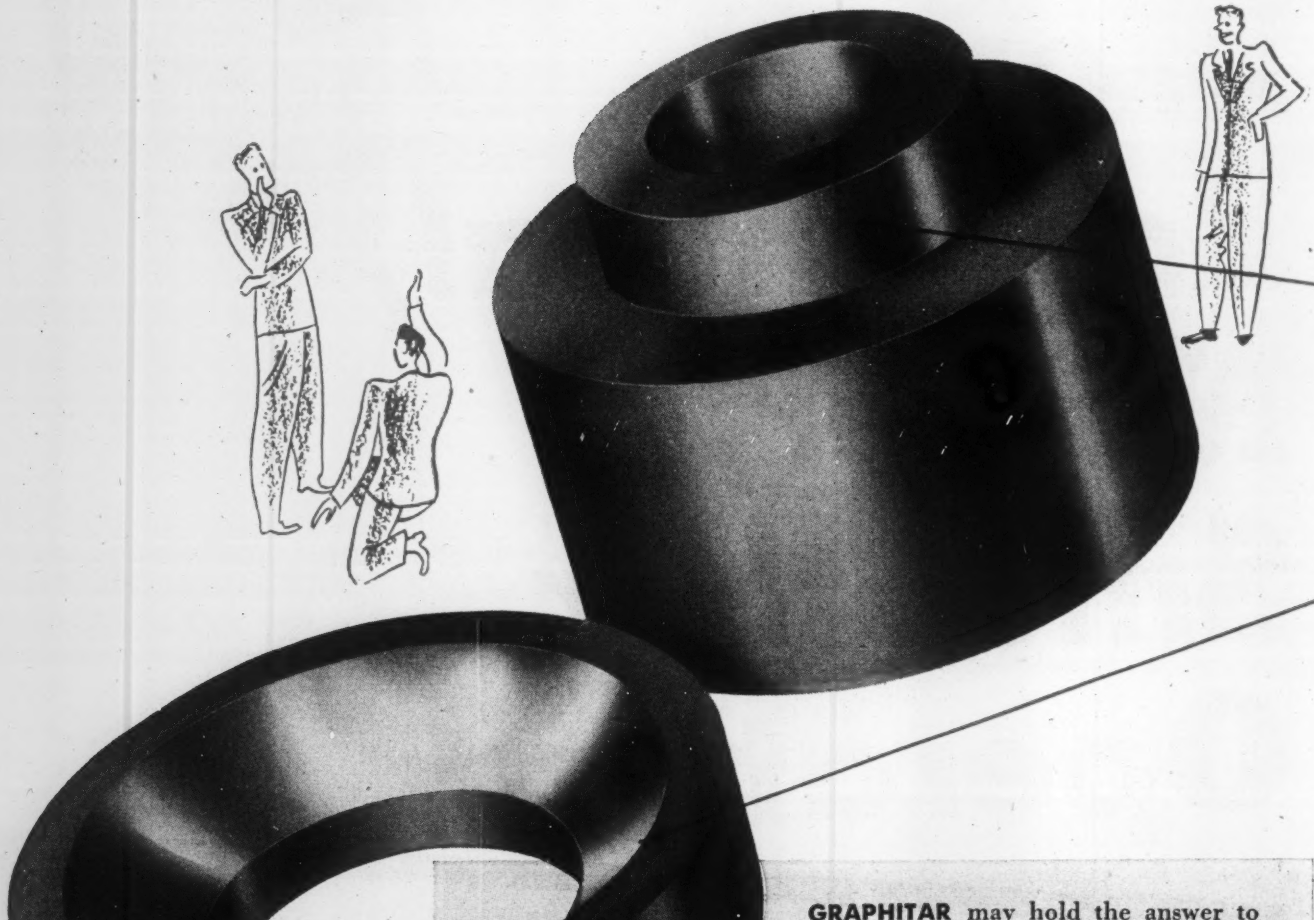
COVER THE EARTH

graphitar

(CARBON-GRAPHITE)

problem in rotary pressure

the Johnson Corporation uses Graphitar

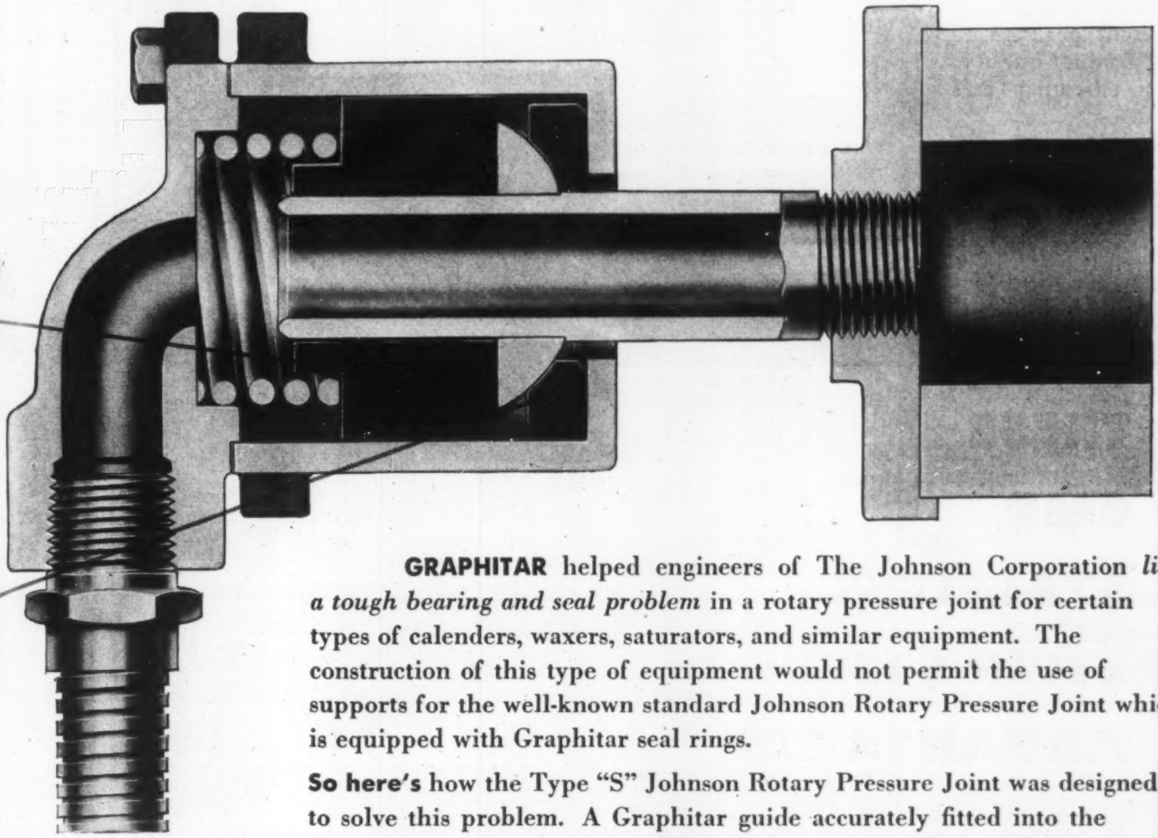


GRAPHITAR may hold the answer to one of your design problems. It is mechanically strong, chemically inert, and highly resistant to wear. It is virtually unaffected by temperature extremes, it's self-lubricating, and extremely light weight. We can mold Graphitar in *a variety of shapes and sizes and finish it to tolerances as close as .0005" in small sizes.* Send us sketches or prints of your products and our engineers may show you where Graphitar will improve mechanical performance and save you money. **Write today for your copy of the 44 page Graphitar Catalog.**

THE UNITED STATES GRAPHITE

provides answer to design joint

Guide and Seal in Type "S" joint

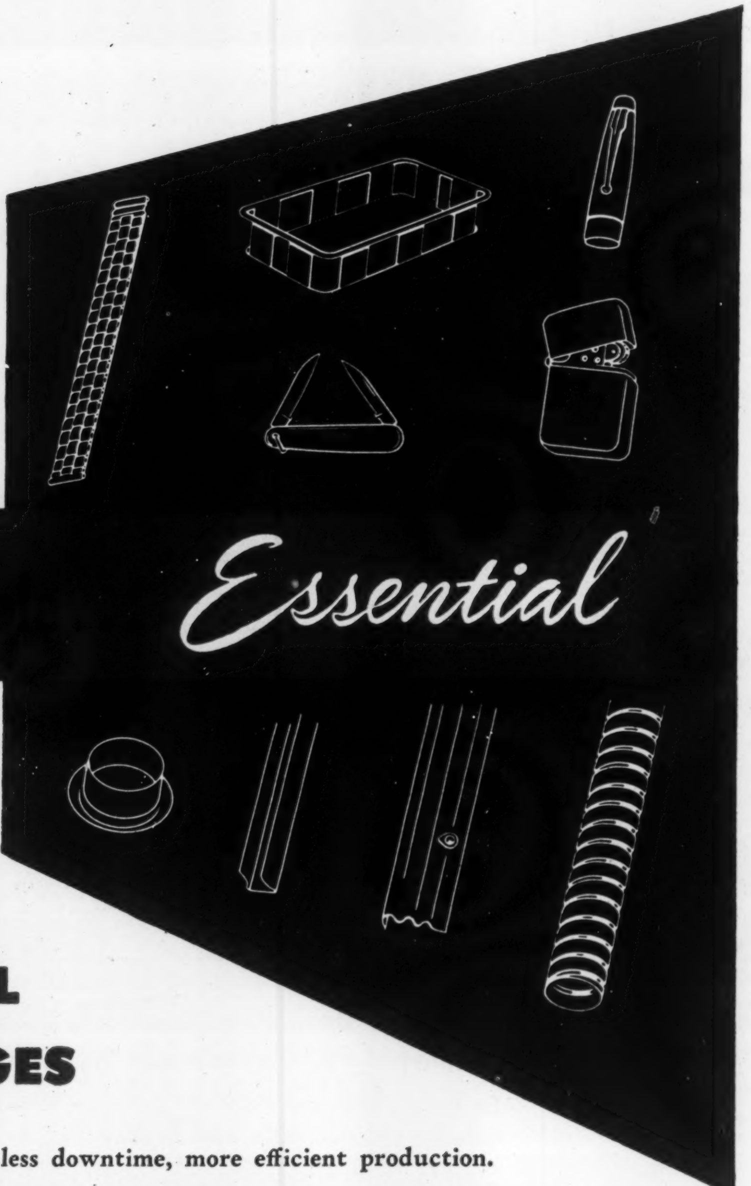


GRAPHITAR helped engineers of The Johnson Corporation *lick a tough bearing and seal problem* in a rotary pressure joint for certain types of calenders, waxers, saturators, and similar equipment. The construction of this type of equipment would not permit the use of supports for the well-known standard Johnson Rotary Pressure Joint which is equipped with Graphitar seal rings.

So here's how the Type "S" Johnson Rotary Pressure Joint was designed to solve this problem. A Graphitar guide accurately fitted into the joint body, as illustrated, provides sufficient support. The convex surface of the collar mounted on the roll rotates against a matching concave Graphitar ring. The result is a *tight, leak-proof seal that assures long-term service,* because tough, strong Graphitar takes on a high polish under load and defies wear. No oiling or greasing is necessary, since the liquid passing through the joints acts as a perfect lubricant for Graphitar.

C O M P A N Y • S A G I N A W , M I C H I G A N

Fabricators unfamiliar with CMP Stainless Strip Steel advantages may well find in them the solution to the present problem of increasing product quality, production efficiency and profit.



more than design . . . *Essential*

THESE CMP STAINLESS STRIP STEEL ADVANTAGES

- Extra long coils — for less downtime, more efficient production.
- Gauges thin as .001″—for lightness with strength.
- Unvarying coil-after-coil dimensional accuracy, physical properties and chemistry.
- Corrosion resistant and heat resistant properties inherent in various grades.
- Wide range of physicals and analyses—tailored for your job.
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- Eye-appeal that gives your product greater sellability.
- Quick mill shipment to keep your production lines running. For detailed information, write, wire or call CMP.

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GIVES MAXIMUM PRODUCTION PER TON

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Which Coupling Shall I Use?

Here are four types of BOSTON couplings suitable for a wide range of applications from "flea" power up to 100 horsepower—available in 69 different stock sizes!

1 This is what is known as the Renold-Hardy flexible coupling and is made up of a flexible disc. of vulcanized rubbered fabric inserted between two metal flanges with hubs. It is available in various sizes capable of transmitting from 1 horsepower up to 100 horsepower.

2 This coupling is known as BOSTON type "FCN"—a three-jaw coupling and is made of a high grade, low carbon content steel with a non-metallic cushion between the jaws to absorb vibration or shocks. It is available in bore sizes ranging from ⅜" to 1½" diameter.

3 This coupling is known as BOSTON type "FA"—a multi-jaw coupling and is made of untreated steel. This coupling is particularly well suited for use with small displays or other light duty applications. It is available in bore sizes ranging from 3/16" to ½" diameter.

4 This coupling is known as BOSTON type "FCB"—a special ball bearing type flexible coupling and is made of case-hardened steel with an insert having hardened and ground steel balls. The greater flexibility of this coupling over an ordinary jaw coupling removes the strain between motor and machine, permitting unrestricted end play of motor shaft. It is available in bore sizes ranging from ⅜" to 1½" diameter.

One of the main features of these couplings is that practically all 69 sizes are carried in stock ready for immediate delivery. Send for your copy of Boston Gear Catalog 54 listing these 69 couplings as well as all other Boston Power Transmission Equipment and Component Machine Parts.

BOSTON GEAR WORKS
DIVISION THE MURRAY COMPANY
NORTH QUINCY 71, MASSACHUSETTS

GENTLEMEN: Please send me______copies of Boston Gear General Catalog 54 containing complete specifications and list prices of your couplings and all other Boston Power Transmission Equipment and Component Machine Parts.

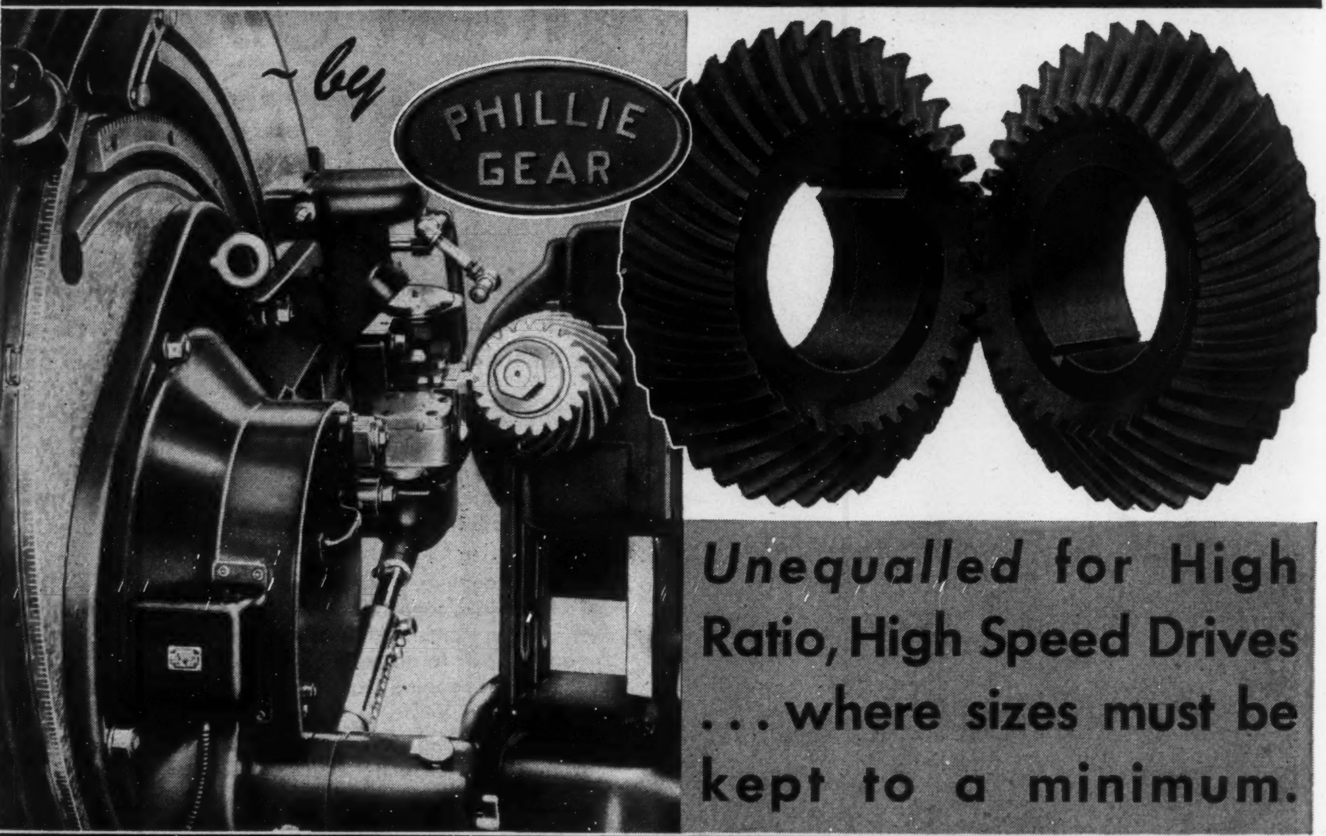
NAME____________________

COMPANY____________________

STREET____________________

CITY____________ZONE______STATE______

Curved Tooth Spiral Bevels



***Unequalled* for High Ratio, High Speed Drives . . . where sizes must be kept to a minimum.**

. . . the *Ideal* combination for power transmission between shafts at any angle and any speed

These gears assure *smoothness, quietness, efficiency, strength* and *durability*. The *unsurpassed performance* of Curved Tooth Spiral-Bevels and Hypoids, is largely due to the curvature and obliquity of teeth—assuring continuous pitch line contact and an overlapping action, which always allows at least *two pairs of teeth to be in contact at all times*—a smooth transfer of load from tooth to tooth (without noise and vibration) and *increased load carrying capacity*, due to the distribution of load over a greater number of teeth.

Large Spiral-Bevels and Hypoids, when specified, have their teeth (only) hardened on our own Surface Hardening Machines,—while smaller gears may be hardened by the induction, straight heat-treating, or case-hardening methods.

NOTE: *Hypoid gears* are similar to Spiral-Bevel gears,—excepting that they have the pinion axis *above* or *below* the center of the gear axis,—and, Hypoids run even *more accurately* and *smoothly* than Spiral-Bevels.

Write us for complete information regarding Spiral-Bevels or Hypoids,—or any other types of gears,—and, please use business letterhead when writing.

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GEAR WORKS INCORPORATED
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Spring Engineering

makes the difference!

If you use springs, you can profit from the moral the illustration points out. The secret to top notch spring performance lies in good spring engineering.

That's why so many spring users install American Quality Springs in their products.

These superior springs have been engineered to resist fatigue . . . hold their shape with unusual success . . . give long and faithful service.

Included in our line of springs is every type and size of compression, extension, torsion and flat spring in common use.

Our unexcelled production facilities mean that you can usually count on speedy delivery of American Quality Springs in whatever quantity you want.

Whether you buy springs ready-made or make them yourself, bring your spring problems to us. Our experts will see to it that you are supplied either with exactly the right springs for your job, or with the best spring wire obtainable for making your own springs.

AMERICAN STEEL & WIRE COMPANY
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Columbia Steel Company, San Francisco, *Pacific Coast Distributors*
Tennessee Coal, Iron & Railroad Company, Birmingham, *Southern Distributors*
United States Steel Export Company, New York
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AMERICAN STEEL & WIRE COMPANY
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AMERICAN SPRINGS
UNITED STATES STEEL

U·S·S American Quality Springs

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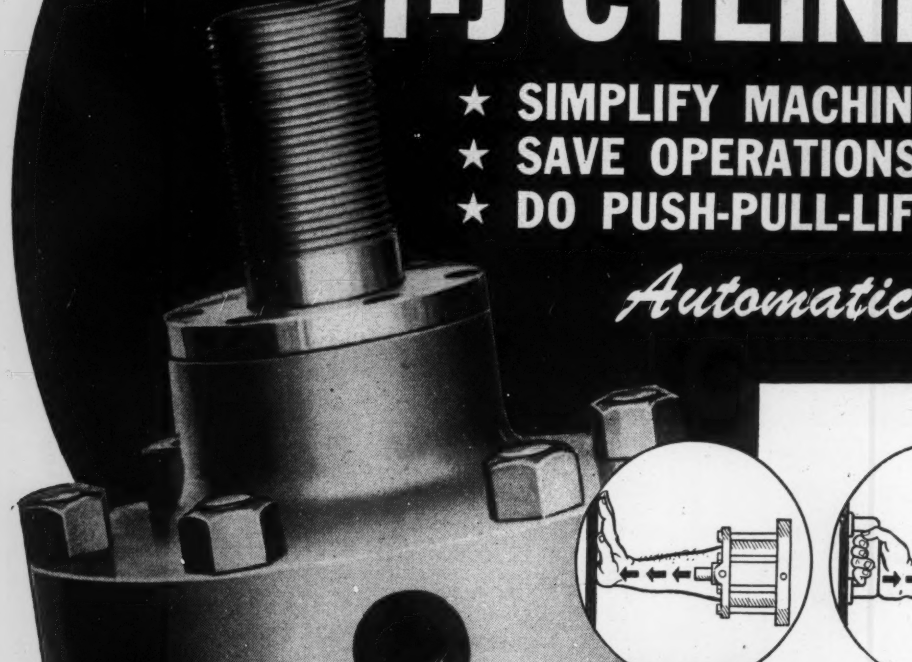
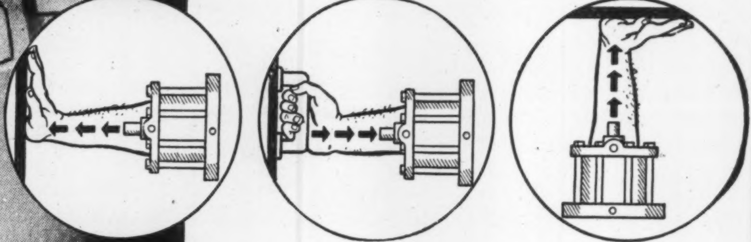
T-J CYLINDERS

- ★ SIMPLIFY MACHINES
- ★ SAVE OPERATIONS
- ★ DO PUSH-PULL-LIFT JOBS

Automatically!





More and more today—industry is *saving labor* by applying T-J Air and Hydraulic Cylinders to operations of all kinds where pushing, pulling, lifting or mechanical control is needed. Available in many standard sizes and styles . . . 100 lb. or 50,000 lb. . . . both cushioned and non-cushioned types. Backed by 30 years of know-how . . . T-J engineered to do the job *better* and *cut costs!* Write today for catalogs.

The Tomkins-Johnson Company, Jackson, Mich.

FOR TOUGH JOBS SPECIFY

T-J

TOMKINS-JOHNSON

RIVITORS . . . AIR AND HYDRAULIC CYLINDERS . . . CUTTERS . . . CLINCHORS

Pre-formed
CARMET CARBIDE
Inserts for
Blanking Dies

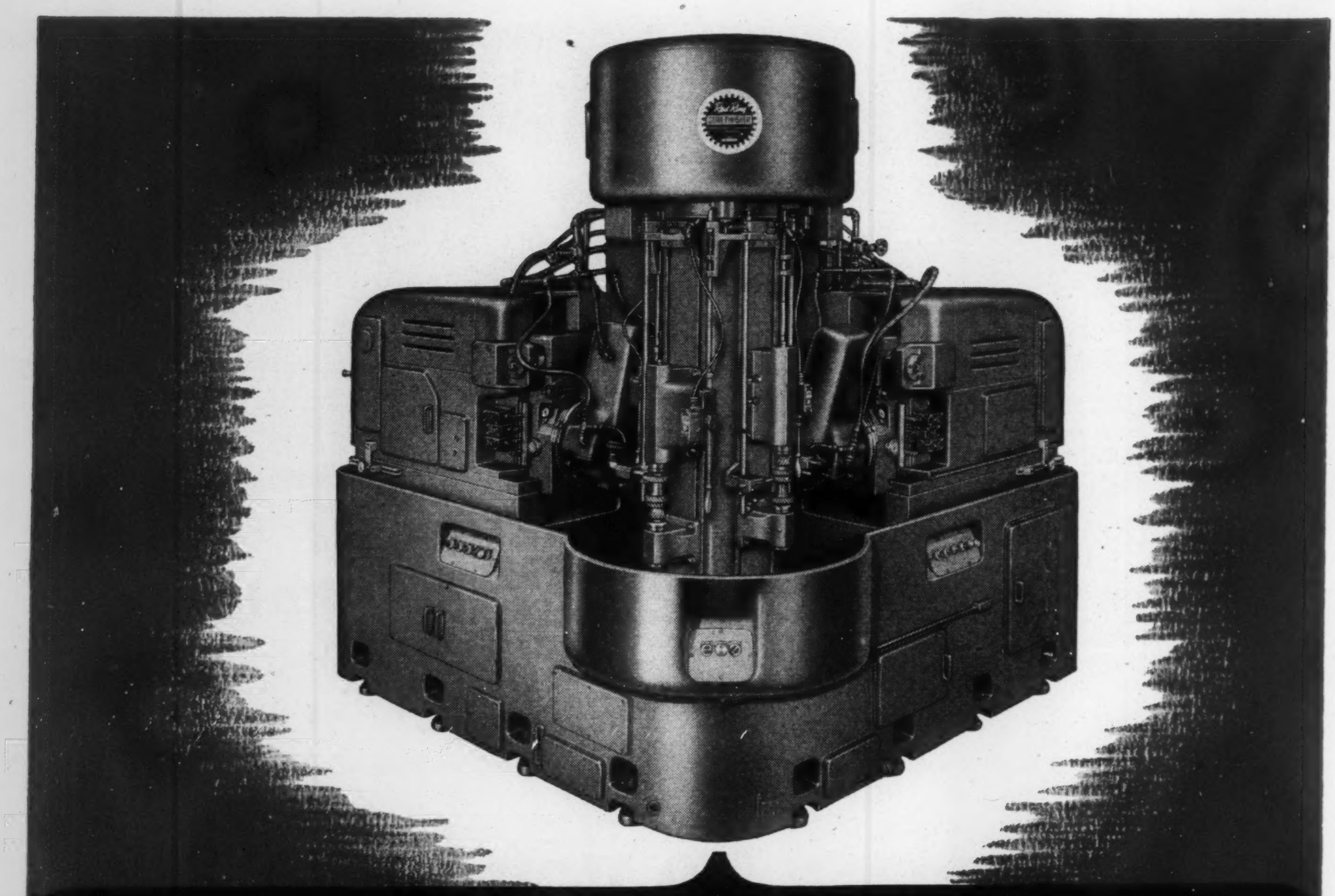
Do you have a "Problem" Part? Make it of CARMET

The Carmet-insert die produces *20 times* more silicon steel blanks before grinding than the die it replaced. Figure the down-time saved, then figure where *you* can use such superior wear-resistance. We preform Carmet sintered carbides to almost any shape or size—supply them finish-ground, too, if you wish. ● Call us in on your problem parts—and don't forget Carmet Tools for best results on your cutting operations.

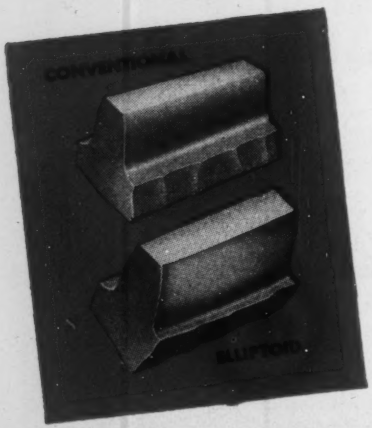
ADDRESS DEPT. MD-49

Allegheny Ludlum Steel Corporation

CARBIDE ALLOYS DIVISION, Ferndale (Detroit), Michigan



NEW *High Production* MACHINE SHAVES TWO GEARS SIMULTANEOUSLY



The new Red Ring Turmatic Gear Shaving Machine is built for fully automatic continuous operation and requires no skill of the operator whatever. He merely loads and unloads the machine. If he should make a mistake in loading a part or try to load an oversize part, the machine stops automatically to safeguard the cutters.

Production rates have been increased 250% plus. Motions in loading the work have been cut from 10 to 4.

Either the conventional tooth form or the Elliptoid form can be produced. All movements are controlled electrically—no hydraulics. Write for descriptive bulletin on this new cost saving gear shaver.

RED RING PRODUCTS

NATIONAL BROACH AND MACHINE CO.

5600 ST. JEAN • DETROIT 13, MICHIGAN

SPECIALISTS ON SPUR AND HELICAL INVOLUTE GEAR PRACTICE • ORIGINATORS OF ROTARY SHAVING AND ELLIPTOID TOOTH FORMS

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with the Bruning BW Direct Line Printing Process

here's what you get

- Sharp, clear prints—in seconds—of anything typed, printed, illustrated or drawn.
- Positive BW Prints (black lines on white backgrounds)—made directly from the translucent or transparent original—without the use of a negative.
- BW Prints with brown, red or blue lines on a white background or black, brown, red or blue lines on a green or pink tinted background.
- BW Prints on thin weight paper, cardweight paper or cloth.
- BW Transparents—intermediate prints useful in making changes or corrections on prints without altering originals—or for salvaging worn or soiled tracings.
- Prints that are easy to read and check—that do not smear or smudge.
- A quick, clean, simple process—no experienced operators needed.
- Compact equipment—to fit your requirements—can be placed anywhere in office or plant.
- A reproduction system which pays for itself through its simple, fast, economical operation.

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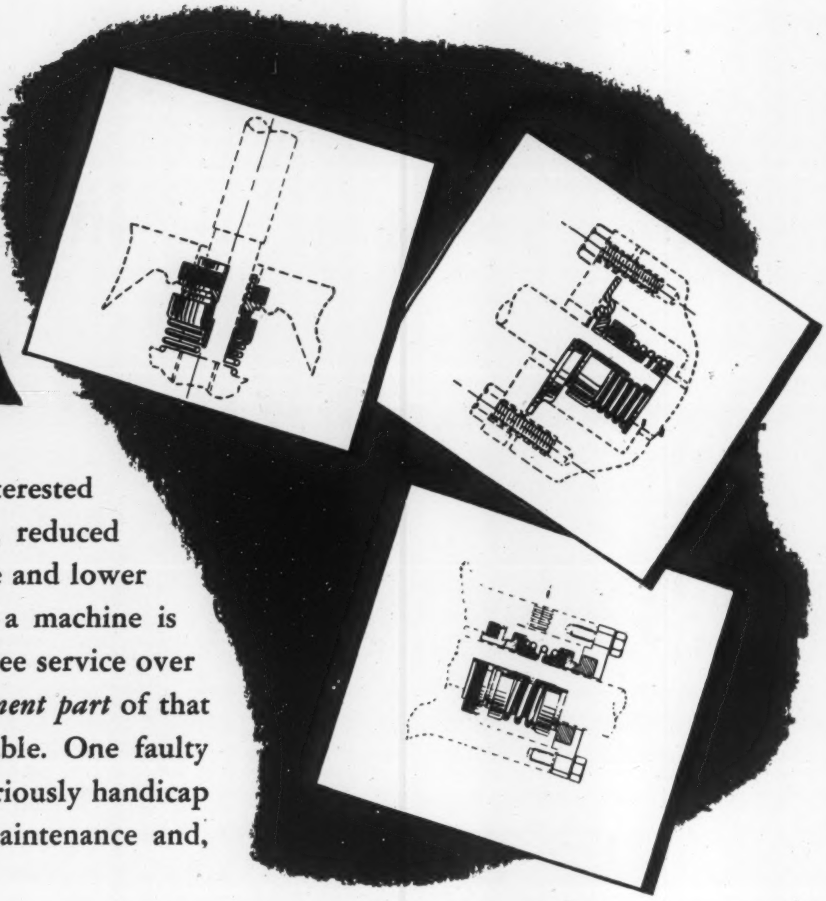
SHAFT SEALING must be *Practical*

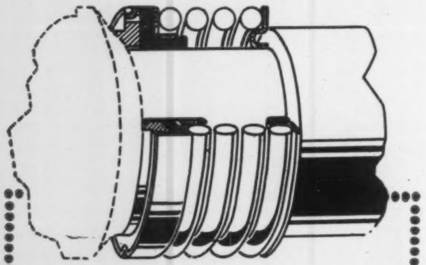


As a design engineer you're interested primarily in better performance, reduced costs, improved appearance and lower maintenance. You know that if a machine is to give reliable, trouble-free service over a long period every ***component part*** of that machine must be equally reliable. One faulty part or sub-assembly can seriously handicap performance, cause excessive maintenance and, eventually, prove costly.

Shaft seals are no exception. In specifying the seal for your machine it is exceptionally important that you select a highly efficient, reliable practical seal.

That is why design engineers who demand top performance in their products choose Rotary Shaft Seals, They *know* the Rotary Seal principle has been tried, tested, proved and has given outstanding service in a wide variety of applications for over 15 years. The simple, direct principles of the Rotary Seal eliminate troublesome complexities, fit specific requirements in a *practical* way, and take the guess-work out of performance.

It will pay you well to investigate the advantages Rotary Seals can give your products.



Know why a Rotary Seal is best?

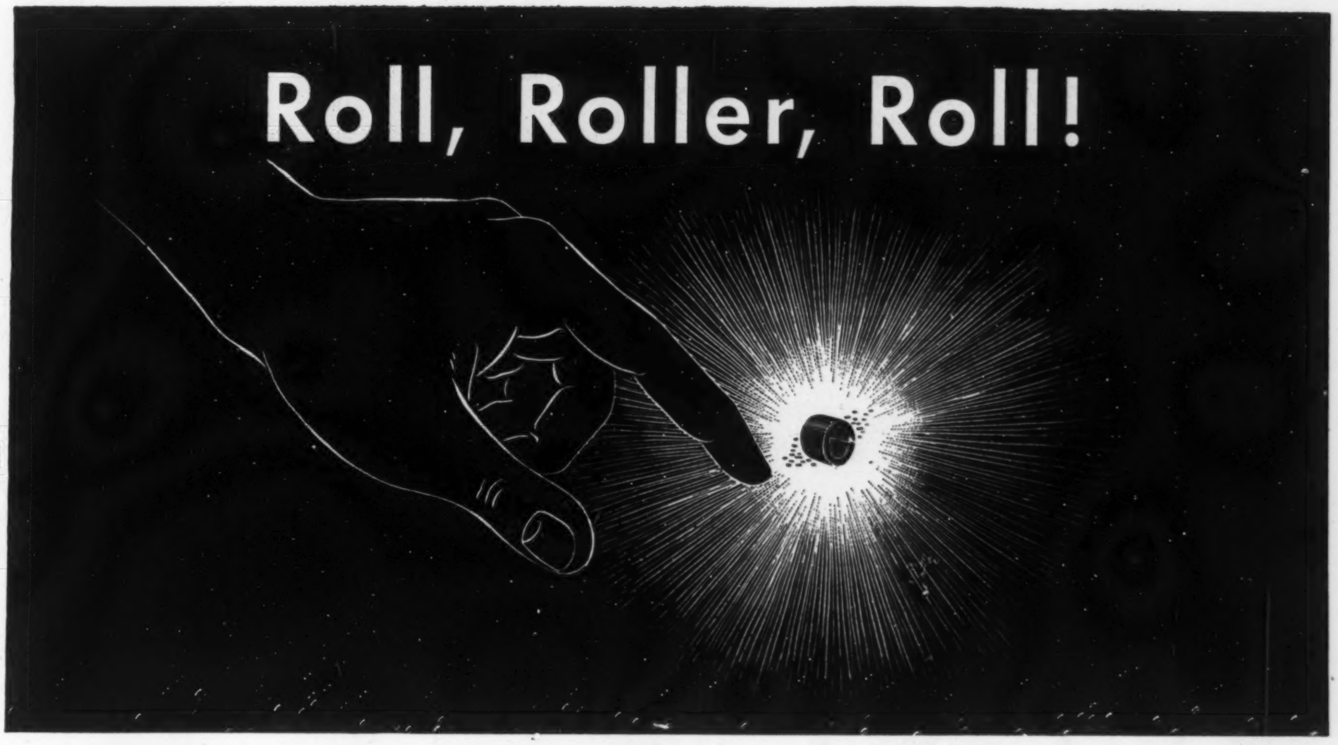
The entire Seal Assembly rotates with the shaft. A running seal joint is formed by continuous, intimate contact between the rotating seal face and the mating, fixed, stationary seal seat. This contact is maintained by the pressure exerted by the coil spring. The flexible, elastic driving member, fitting frictionally tight around the shaft, acts to prevent leakage at that point. The seal face can adjust its running plane—either angularly or laterally — to compensate for shaft vibration, deflection or slight misalignment. Simplicity in design and function are basic reasons for the efficiency and practicability of the Rotary Seal principle.

Send for Booklet

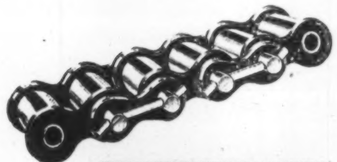
THE ROTARY SEAL COMPANY
mechanical seals for rotating shafts

ROTARY SEAL COMPANY, 2022 N. Larrabee St., Chicago 14, Ill.

Roll, Roller, Roll!



This short length of UNION roller chain is made up of the 28 separate parts shown below.



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Look at the "exploded" drawing below. There you see 6 such rollers in the short length of chain shown at the left. You also see there 28 separate parts in this same length of chain. To make these 28 parts, exactly 290 operations are required, **all under rigidly controlled inspection.**

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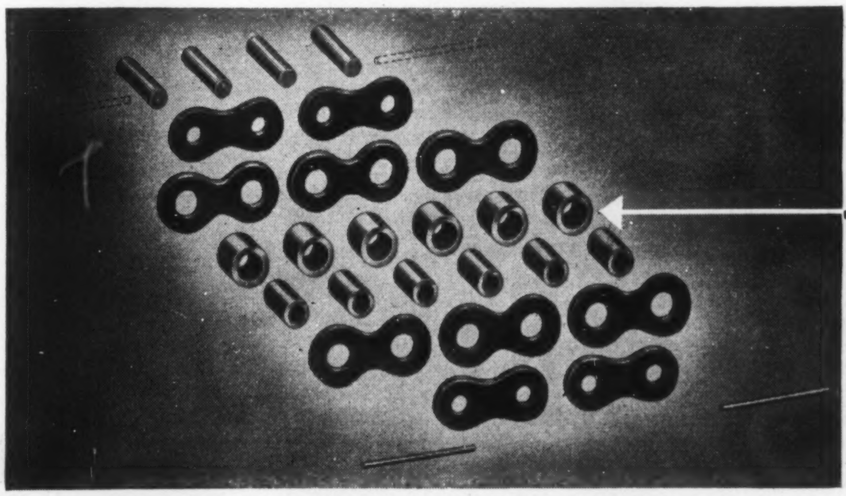

THESE 10 OPERATIONS TO MAKE THIS STEEL ROLLER

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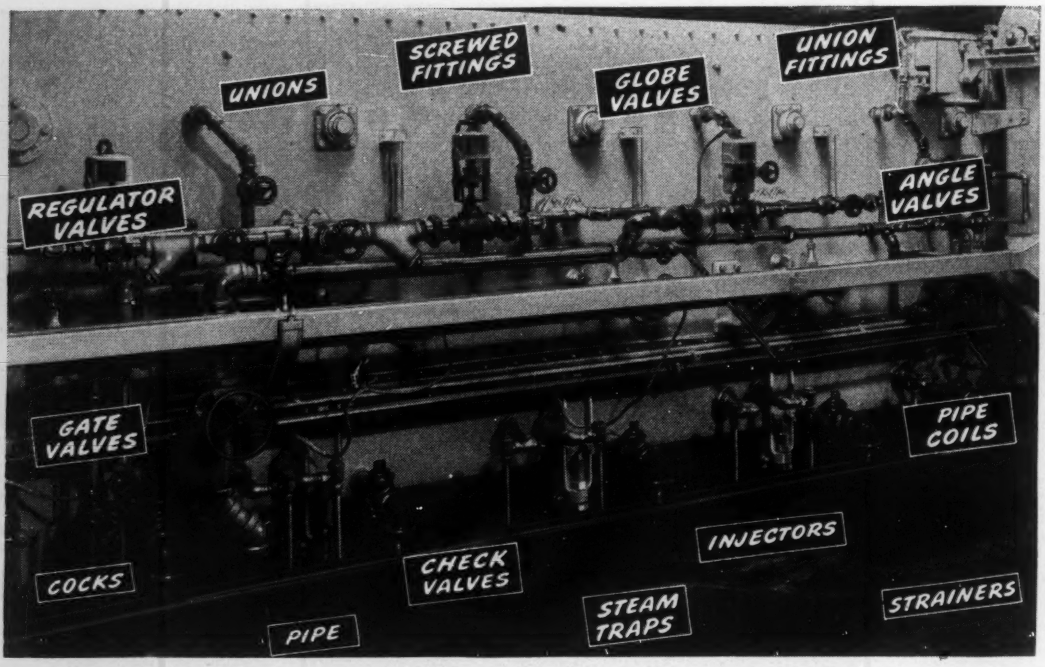
3. curl
4. roll
5. grind
6. de-grease
7. heat treat and quench
8. temper
9. clean and polish
10. color



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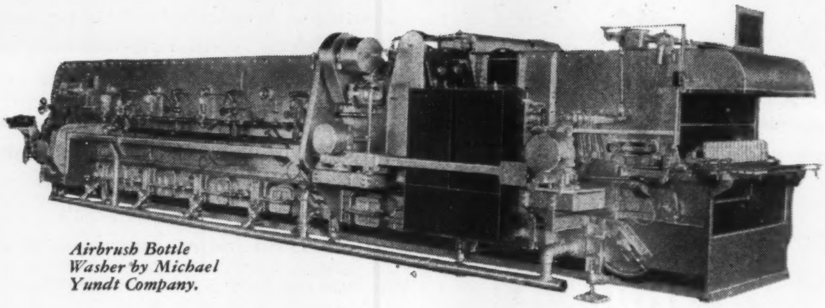

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TEMPERATURES close to absolute zero are developed in the Collins Helium Cryostat. This device, now being built by Arthur D. Little Inc., is the first equipment to be regularly produced for maintaining temperatures as low as 456 degrees below zero.

BROACHING of narrow openings in stacks of stampings, such as cores of small motors, is considered by the General Electric Co. as the most effective method of removing burrs and small irregularities from this type of assembly.

GYRO-GLIDER, an odd-looking wingless aircraft, works like an autogiro without a power source. Weighing 120 pounds or 1/3 the weight of a standard glider, it is flown with the aid of two 9-foot rotating blades and is capable of lifting a load of nearly 300 pounds.

ELECTRODEPOSITION of tungsten alloys on metal surfaces has been developed experimentally at the National Bureau of Standards. Of the alloys investigated, cobalt - tungsten was found to deposit most easily. Nickel-tungsten and cobalt-tungsten deposits have good adhesion to steel and can be plated up to a thickness of 0.02-inch without becoming appreciably nodular. As formed they are brittle and have laminar structure, but heating to suitable temperatures results in the disappearance of the laminations as the alloys become ductile.

FIRST ANNUAL Distinguished Service Award to be presented by the Special Devices Association has been presented to General Motors in recognition of "outstanding accomplishment in its scientific programs involving rapid learning techniques and mass training." The association is composed of Naval Reserve officers and civilians who have served in the Special Devices Center, Office of Naval Research.

HANDLING of materials, a completely nonproductive operation, constitutes from 12 to as much as 50 per cent of total labor costs in various industries. If manufacturers are to avoid pricing themselves out of the market this unproductive burden must be cut down, according to Edwin J. Heimer, president of Barrett-Cravens Co.

FIRST GRAND AWARD in the Design-for-Progress program of the James F. Lincoln Arc Welding Foundation was awarded to members of the Aeromatic Propeller Department, Koppers Co. Inc. for their paper, "Development of Arc Welded Propeller Hubs." Using tubular design, arc welded, the weight of the hub was reduced 31.5 per cent over previous design. Features of this hub were discussed in MD, April, 1946, Page 141.

ORGANIZED to conduct research and provide services in the field of applied mathematics, the National Applied Mathematics Laboratories—a division of the National Bureau of Standards—will develop and use modern high-speed computing equipment to serve the physical and engineering sciences.

FACTORS IN CHOOSING RESILIENT GASKETS
FIGURE 1
FIGURE 2
FIGURE 3
12

FACTORS IN CHOOSING RESILIENT GASKETS

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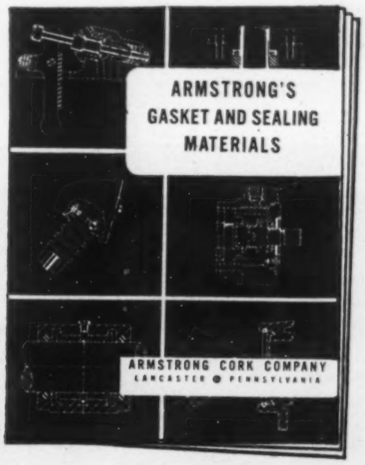
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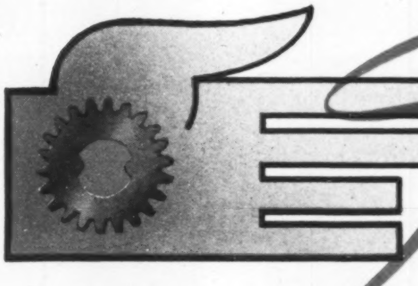

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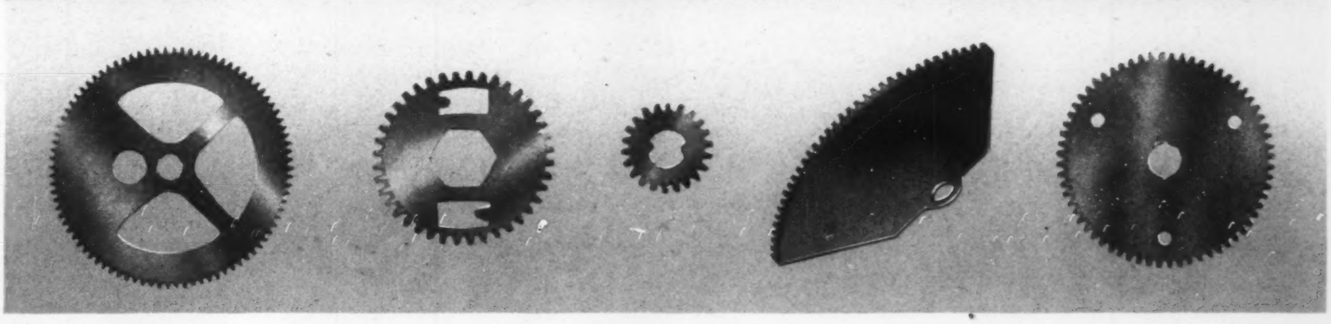

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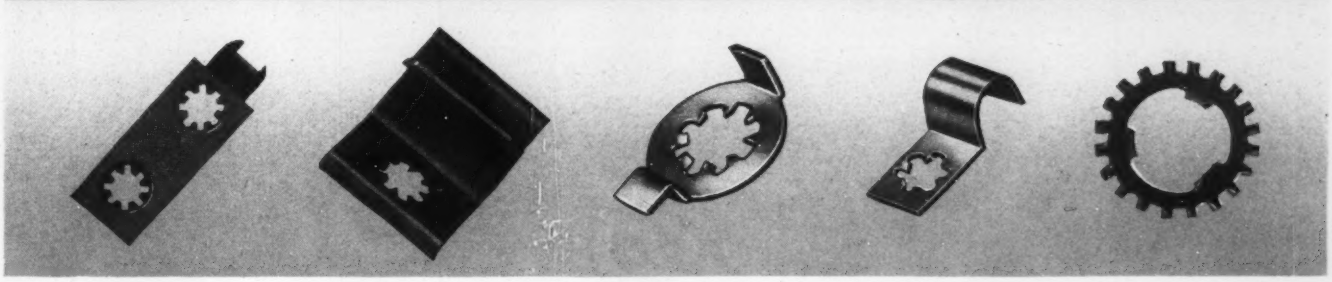

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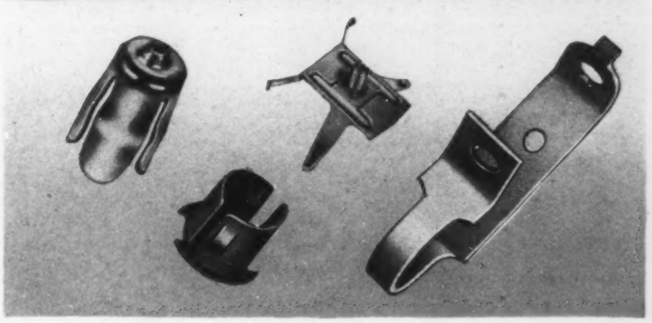

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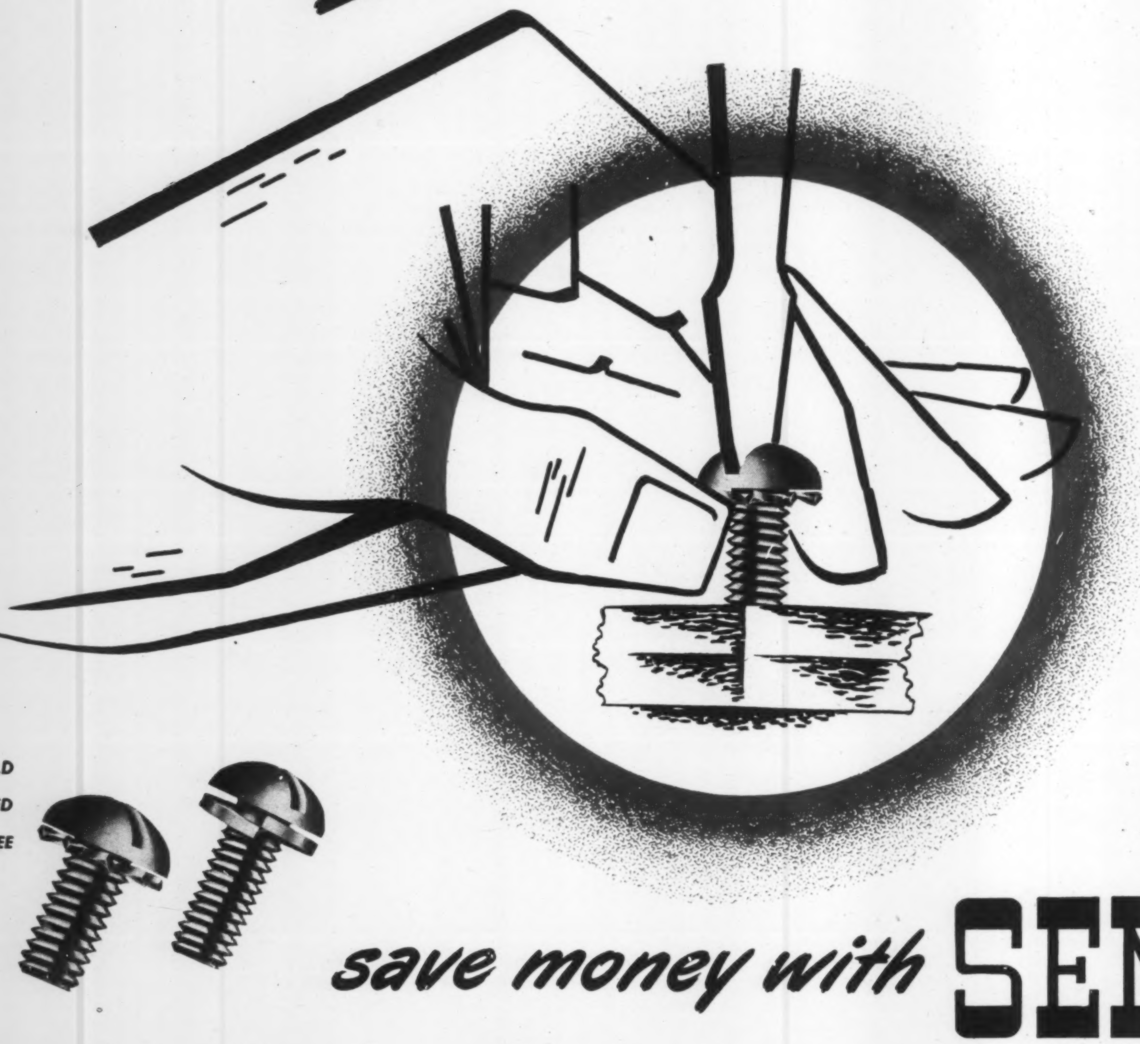

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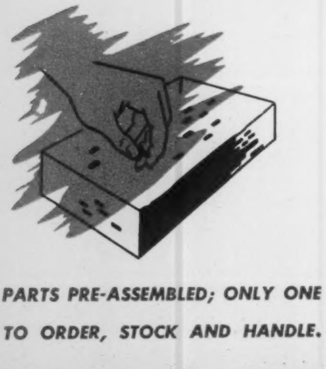

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MACHINE DESIGN

Hydraulic-Electric System

. . . expedites inspection in machine

By Walter E. Bock
Electrical Engineer
Magnaflux Corp.
Chicago

MANY manufacturing concerns are regularly confronted with problems involving the design and manufacture of equipment to meet stepped-up production requirements. Reducing handling of

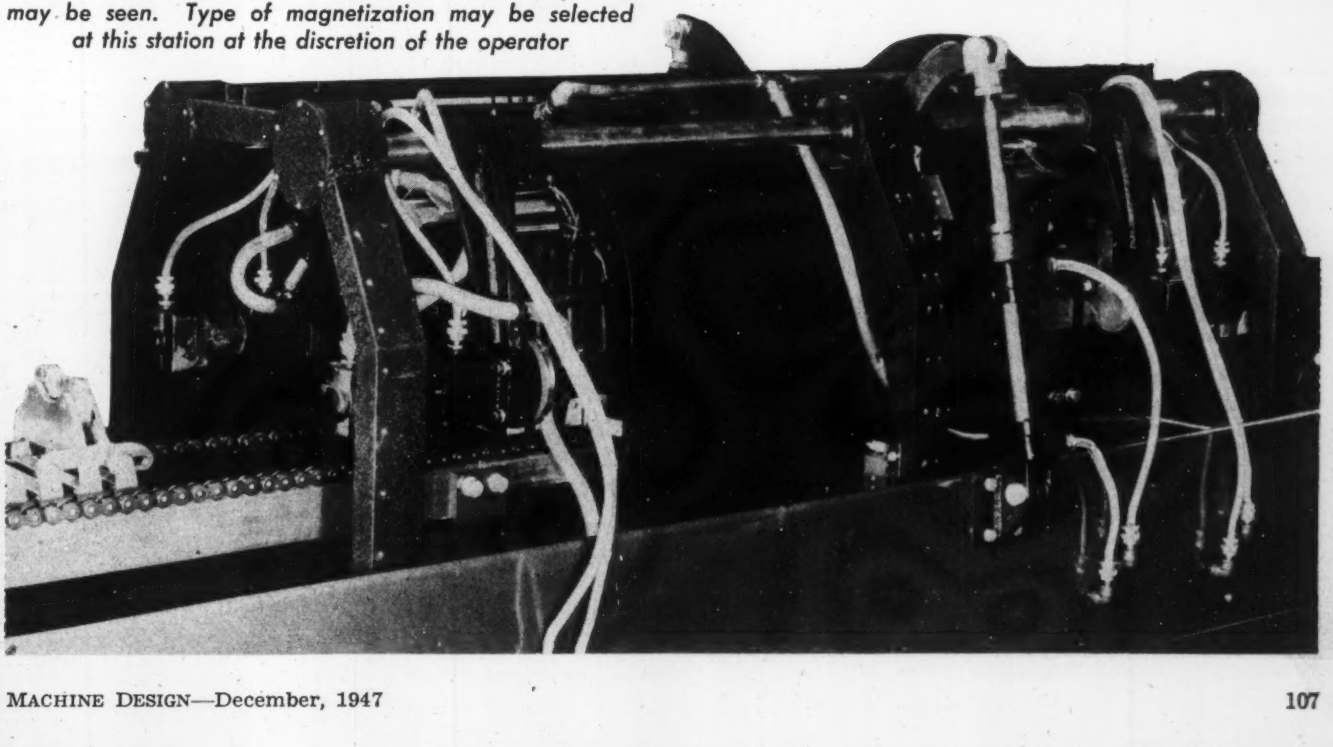


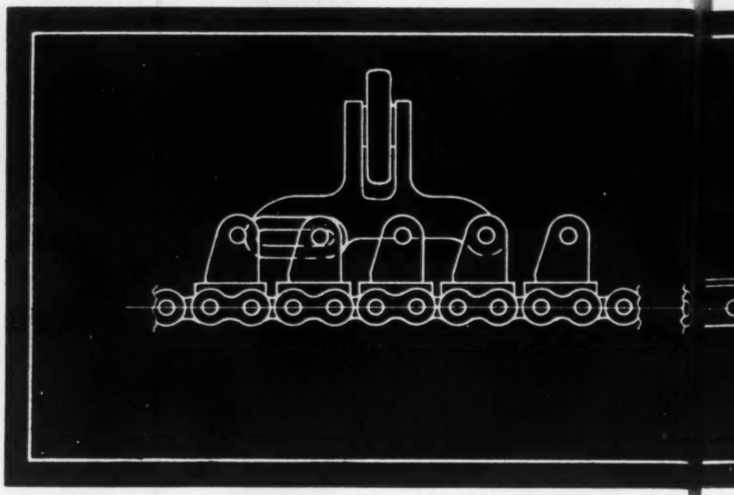
Fig. 1—Crankshaft-inspection unit showing magnetization station. Two sets of contact heads and their lift cylinder may be seen. Type of magnetization may be selected at this station at the discretion of the operator

a particular item during processing, minimizing labor costs and increasing production rates are a few of the foremost thoughts in the minds of up-to-date production personnel. It was in response to these needs that automatic machines for inspection of crankshafts and camshafts with Magnaflux—a method using magnetic-particle inspection—were designed and manufactured.

Numerous types and styles of automatic inspection machines have been designed for particular production-line applications but this article deals primarily with the design features incorporated in the machine shown in *Figs.* 1 and 2. Greatly increased numbers of highly stressed structural members are used in present-day machinery, the physical sizes of which have been reduced to decrease weight and increase efficiency. Design and process engineers, metallurgists and inspection personnel have come to realize the advantages of this type of inspection in their plant production lines.

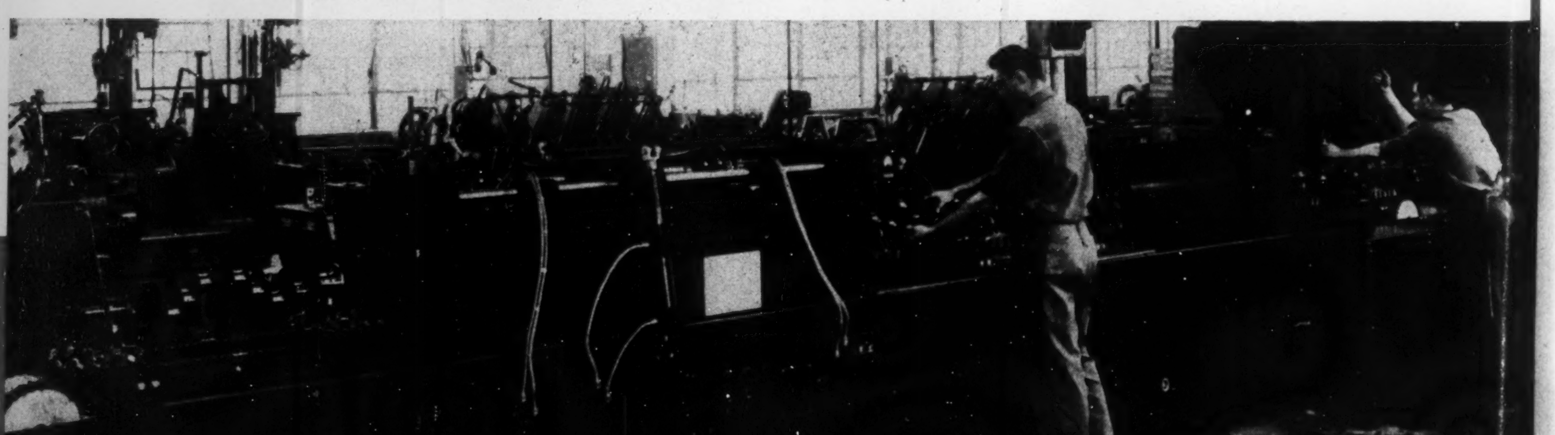
The problem to be considered first when designing a machine of this type is how to handle the parts through the machine. Then follow the "musts" which are requirements of the magnetic particle inspection method itself, the plant handling method, and the nature of the parts being inspected. To indicate the operations required of the machine, a brief summary of the magnetic-particle inspection follows:

1. Magnetization: The part to be inspected must be of magnetic material since the process depends on a leakage field at a discontinuity in the material
2. Application of Magnetic Particles: The magnetic particles are applied to the part in dry powder form or in suspension in light oil. The magnetic particles may be applied just prior to magnetization using the process known as the "continuous method" or applied after magnetization using the "residual method." The latter method, of course, can be used only when there is sufficient residual magnetization remaining in the part to attract the magnetic particles
3. Inspection: Any discontinuity in the part will make itself visually apparent to the inspector by a "build-up" of magnetic particles on the surface above the discontinuity
4. Demagnetization: If the part requires further machining or is ready for assembly into the finished product a magnetic field remaining in the part may be undesirable; demagnetization is then provided
5. Rinse: This step is provided to remove any excessive accumulation of magnetic particles from the part when needed for the next step in fabrication.



Requirements of the machine illustrated in *Fig.* 2 are that it must be capable of handling thirty different truck crankshafts and accepting two sizes at any one machine set-up, since two production lines feed the machine at a combined production rate of one per minute. It was desired that a rapid and convenient means of changing the machine set-up be provided in the event the crankshaft in production be changed. It was also desired to have some simple arrangement whereby the operator might change the magnetizing field to either circular or longitudinal by merely changing a switch setting. The parts must be demagnetized and rinsed, a requirement dictated by the next step in their processing. To make the machine even more flexible, adjustable controls are

Fig. 2—Automatic Magnaflux inspection machine. Magnetization station, shown in Fig. 1, is seen at center of machine. Support fixture, Fig. 3, may also be seen



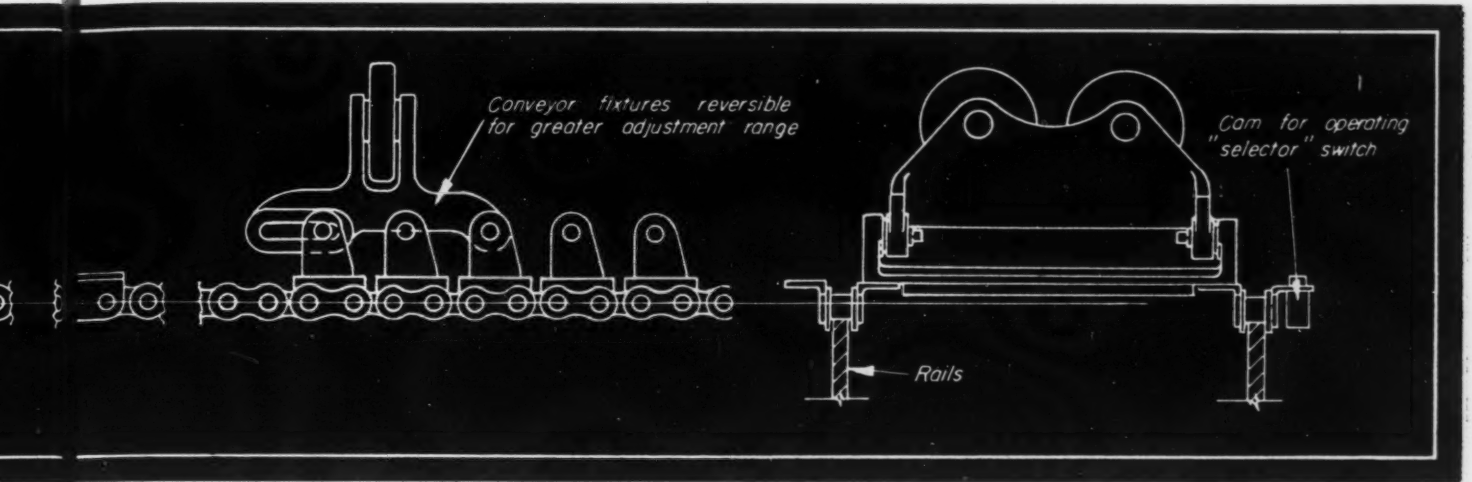

Conveyor fixtures reversible for greater adjustment range
Cam for operating "selector" switch
Rails

Fig. 3—Support fixtures for carrying crankshafts are adjustable for thirty different sizes. Drawing shows one station on chain. Fixture may also be seen in Fig. 2

provided so that the operating cycle of the machine might be varied to conform exactly with the rate of the production lines feeding the machine.

Because the application of Magnaflux inspection to the crankshaft requires that the conveyor be at rest during certain steps, an intermittent type of drive assembly is incorporated. A hydraulic system provides a smooth and easily controlled drive for the conveyor and also powers the lifting and clamping of the two sets of contact heads in the magnetizing station, providing for better timing and sequencing of the operating cycle of the machine. Low voltage, alternating current produces the magnetic field used with the wet-continuous method. Demagnetization is accomplished with the part at rest in a coil which has its field strength reduced from a maximum to a minimum value in thirty steps.

Considering the foregoing the machine shown in *Fig.* 2 was designed to have the following sequence of operations:

1. Part is loaded on conveyor fixtures with conveyor at rest
2. Part advances to magnetizing station where it is sprayed with the inspection medium for a predetermined period. Spray is cut off and magnetizing current flows for about one-half second. These phases of the cycle are performed while the crankshaft is at rest
3. Part is advanced to the inspection station where, while at rest, the inspector manually rotates the crank and examines for defects
4. Part is advanced to the demagnetizing station where, while at rest, the thirty point switch gradually reduces the coil field strength to a point where practically no residual field remains
5. Part passes through a spray rinse which removes excessive magnetic-particle accumulations and then advances to unloading station.

Fixtures on the chain conveyor not only provide support but also permit the crankshaft to be rotated easily so that all surfaces could be made visible for inspection. The supports are adjustable so that they can accommodate the many sizes involved. It is also necessary to support the crankshafts on the front and rear bearings for easy and rapid inspection. Support fixtures as shown in *Fig.* 3 are designed to meet these varied requirements. Since the difference in length between the shortest and longest crankshafts is too great to provide clamping cylinders with strokes sufficient to meet all conditions and since two sizes are inspected in mixed batches at any one machine set-up, two sets of contact heads are provided as shown in *Fig.* 1. In order to determine which set of heads is to be operated, a small cam, *Fig.* 3, is attached to the corresponding side of the chain conveyor between each set of fixtures. This cam actuates a limit switch to give the signal. The contact heads are used only for circular magnetization. For longitudinal magnetization, the coil, partially shown in *Fig.* 1, is used and the cam then serves no purpose. The contact heads are adjustable for proper spacing by sliding along the horizontal shafts.

Dual Control System Used

The two sets of clamping and lifting cylinders made it necessary to design a hydraulic system with duplicate sets of hydraulic control valves as shown in *Fig.* 4. The drive cylinder operation is controlled through valves in the same hydraulic system. The position of the hydraulic drive cylinder and its relation to the mechanical linkages connecting it to the conveyor chain are illustrated in *Fig.* 5. Because of the intermittent drive requirements, and the 64-inch movement required of each stroke with a minimum amount of over-travel, the final design as illustrated was concluded to be the most practical.

A reciprocating gear-rack with flanged, ball-bearing wheels operating on a track, engages the gear assembly to drive the conveyor. A three-toothed ratchet and pawl in the gear assembly provide the intermittent motion, the pawl being required to move the ratchet through approximately 240 degrees to obtain the 64-inch motion of the conveyor. This type of drive mechanism was found to provide a smooth-driving action from low to maximum speeds. Provisions were made in the hydraulic system for easily adjusting the speed of the outward and return strokes

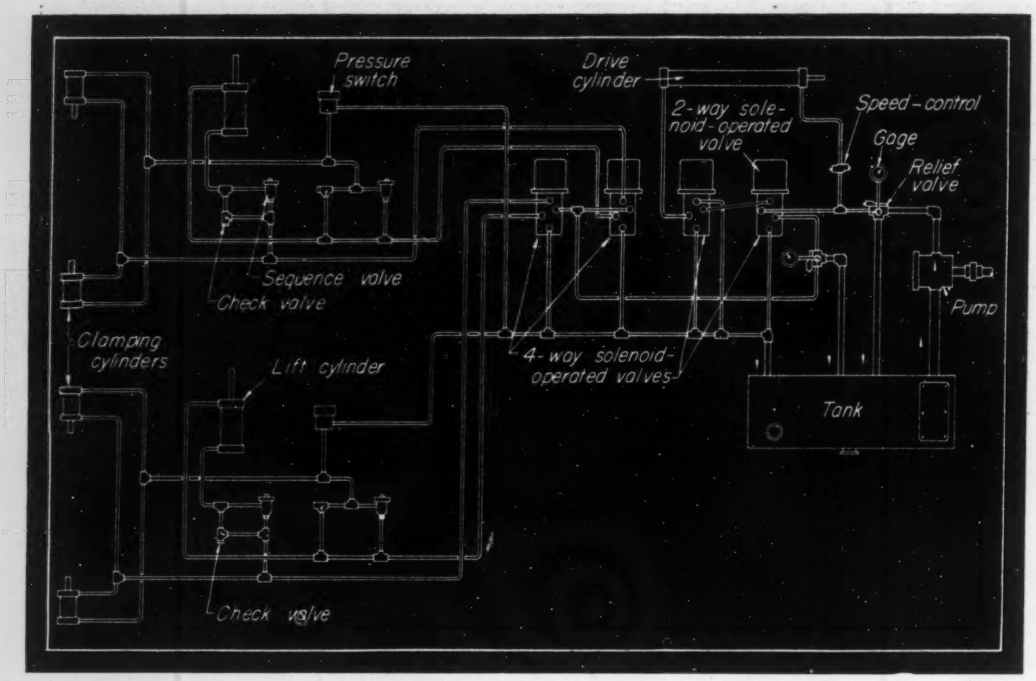

Pressure switch
Drive cylinder
2-way solenoid-operated valve
Speed-control
Gage
Relief valve
Sequence valve
Check valve
Pump
Clamping cylinders
Lift cylinder
4-way solenoid-operated valves
Tank
Check valve

Fig. 4 — Left — Hydraulic system of inspection machine showing relationship of cylinders and control valves

of the piston in the drive cylinder to effect a better timed and regulated operating cycle for the machine. This eliminated the need of a manual change of gears, or of variable-speed transmission, clutch, or brake for proper timing. By merely adjusting the speed-control valve, *Fig.* 4, and an electrical timer in the control circuit, all operating and rest speed changes are selected at the discretion of the operator.

Limit switches, shown in *Fig.* 5, are actuated by the gear-rack assembly. These switches have the function of initiating the operating cycle of the machine. The limit switches, seen in *Fig.* 1, act as intermediary switches for controlling proper operations at the magnetizing station. Two of these, as previously discussed, are actuated by the cams on the chain conveyor for selecting the set of contact heads which are to be operative. When the transfer switch on the front panel is changed to the "coil" position for longitudinal magnetization, the intermediary switches are out of the circuit.

Adapting the machine for either circular or longitudinal magnetization by merely changing a switch

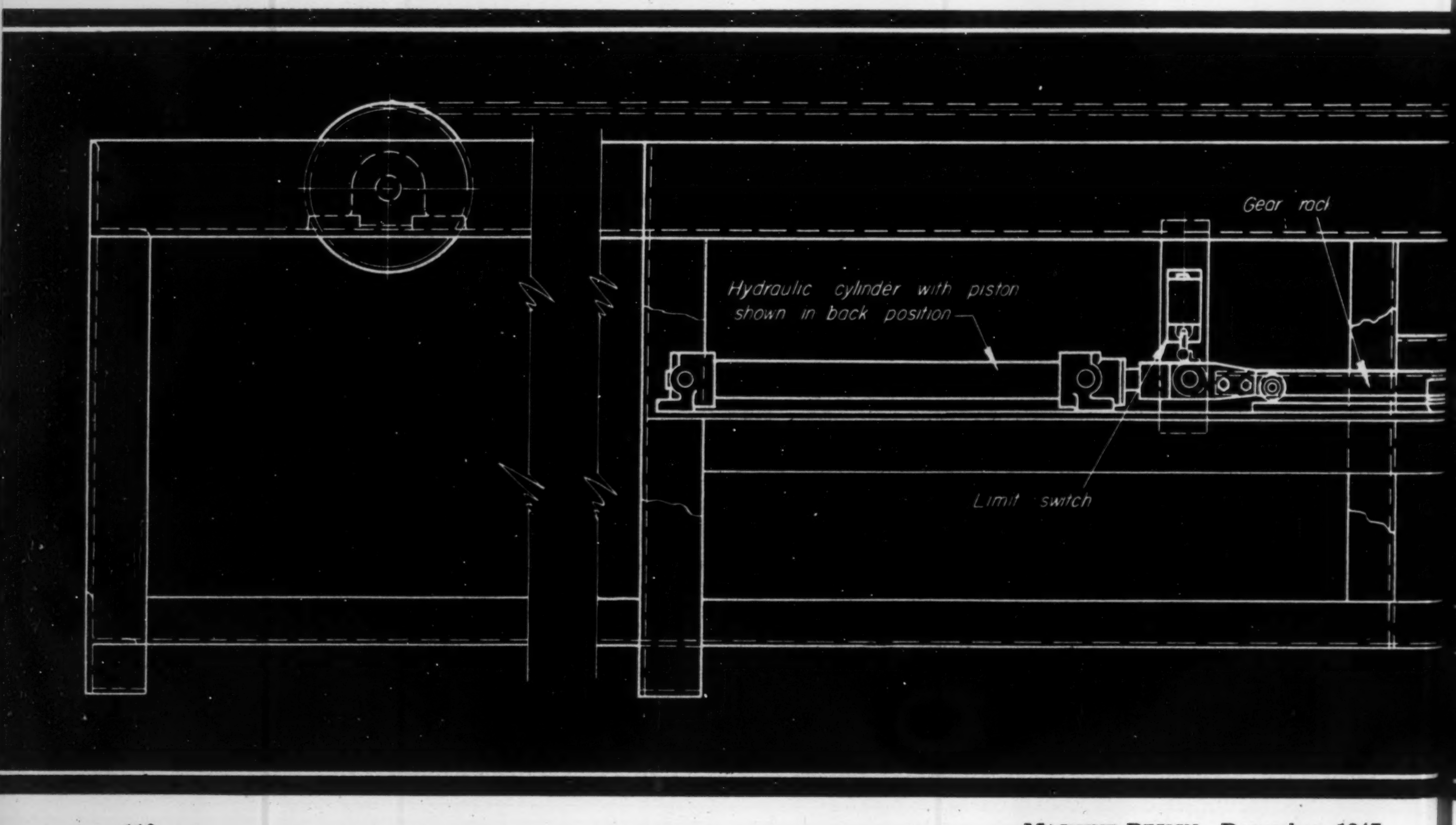

Gear rack
Hydraulic cylinder with piston shown in back position
Limit switch

Fig. 5 — Below — Drive mechanism and limit switches. Intermittent-drive employs a cylinder to operate a ratchet and pawl arrangement

setting appeared simple on the surface but, on actual designing of the circuits, many unforeseen complications were encountered. Increased voltage was required for coil operation. Spray time for applying the magnetic particles to the surface of the crankshaft had to be different since, when using circular magnetization, this is done while the heads are being lifted and the crankshaft is being clamped. Other problems came up, such as holding certain solenoid valves inoperative while others were allowed to function, maintaining the demagnetization cycle constant while other electrical cycles varied, etc.

These problems could easily have been solved by the addition of duplicate electrical equipment at a much added cost and the use of valued space in the lower compartments of the machine, but this was not desired. After numerous circuit diagrams had been developed and experimental bread-board set-ups made in the laboratory it was found possible to obtain the desired results by the addition of two limit switches, two relays, two pneumatic timers, and two large magnetic contactors. A safety limit switch installed at the unloading station automatically stops the hydraulic pump motor in the event the part at that station is not removed before the conveyor starts to advance.

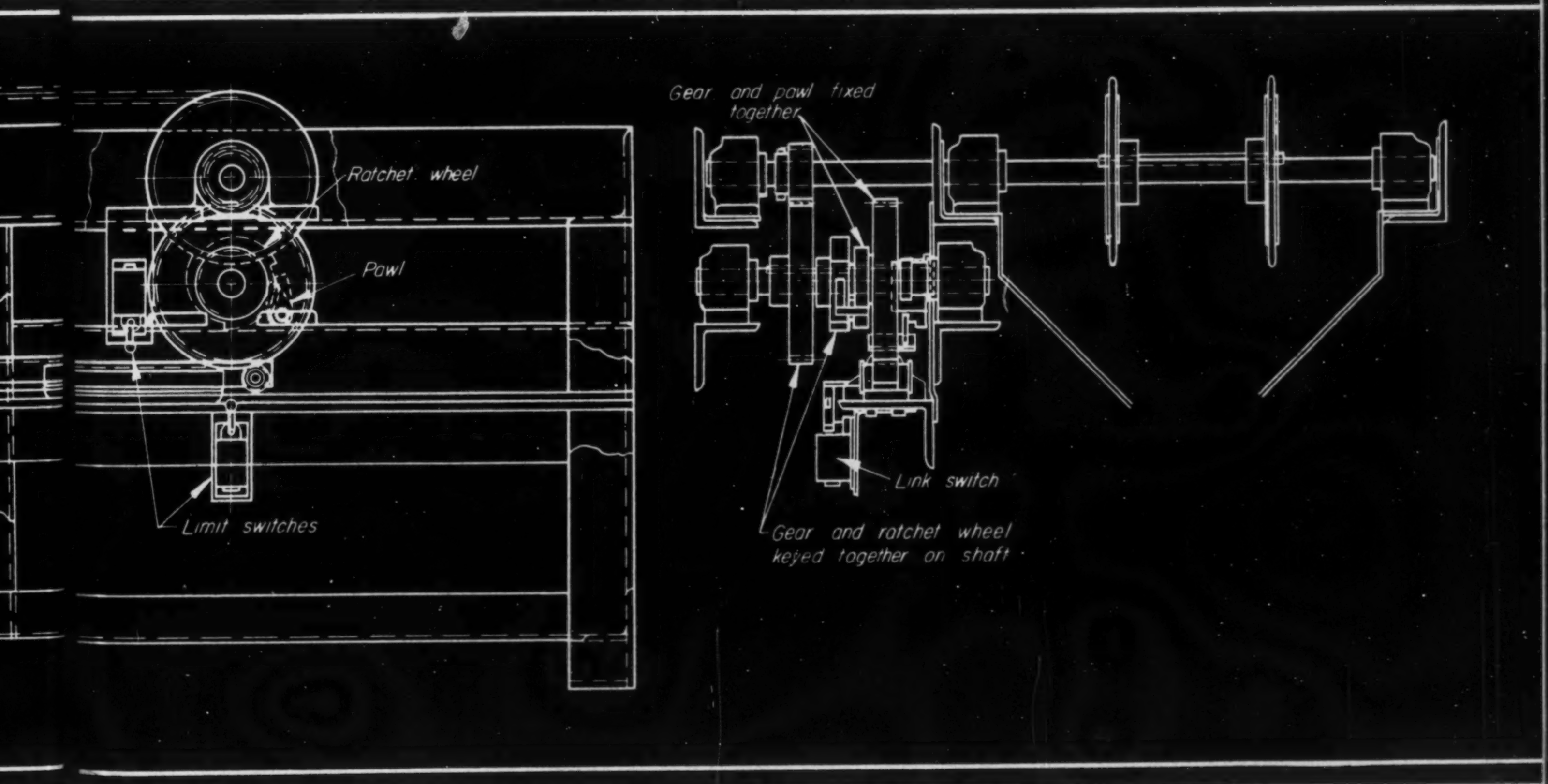
Operating sequence of the hydraulic circuit for a cycle incorporating circular, or contact head, magnetization includes:

1. Drive cylinder moves forward, advancing conveyor one station, or 64 inches
2. Lift cylinder swings contact heads into position and part is sprayed
3. Clamping cylinders move forward, mechanically contacting part
4. When good mechanical contact is effected, spray is cut off and magnetizing current is passed for one-half second
5. Clamping cylinders retract
6. Lifting cylinder returns contact heads to rest position
7. Electrical timer comes into play to effect the dwell, or rest, period deemed necessary for adequate inspection time
8. Drive cylinder retracts.

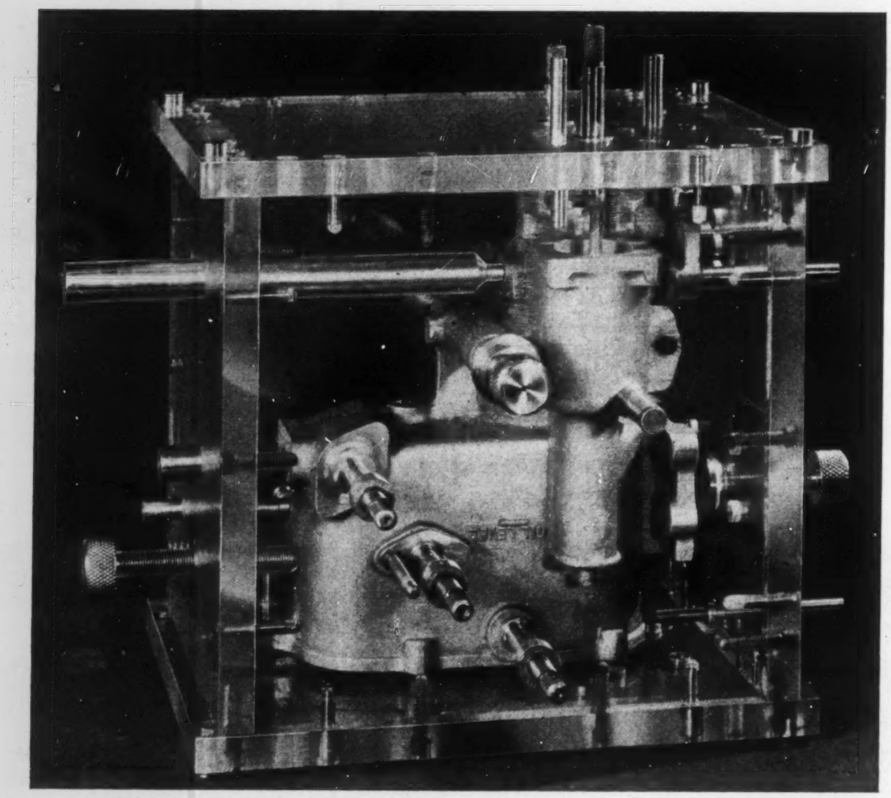
With all controls so closely related and tied together, the various steps in the operating cycle must occur in a definite and fixed sequence. If one step in the cycle fails to complete its course or fails to occur at all, the machine will immediately cease functioning. Each step in the cycle has to complete its full course before the following step will begin. These features provide for safety and prevent damage to parts of the machine in the event trouble develops in any portion of the electrical control circuit.

Because the machine can be turned off at any point in the operating cycle—resulting in certain relays, timers, solenoid valves, etc., becoming de-energized—a special electrical "brain" circuit is incorporated in the control circuit. This circuit is necessary to automatically remind the machine where it should again start functioning in the cycle after stoppage.

The frame is all-steel welded construction, designed to withstand the demands on such equipment. Structure and panels are sprayed a machine-tool gray while the hoods and other assemblies above the frame are black-wrinkle painted to provide a pleasing appearance when arranged with other machines in the **production line.**

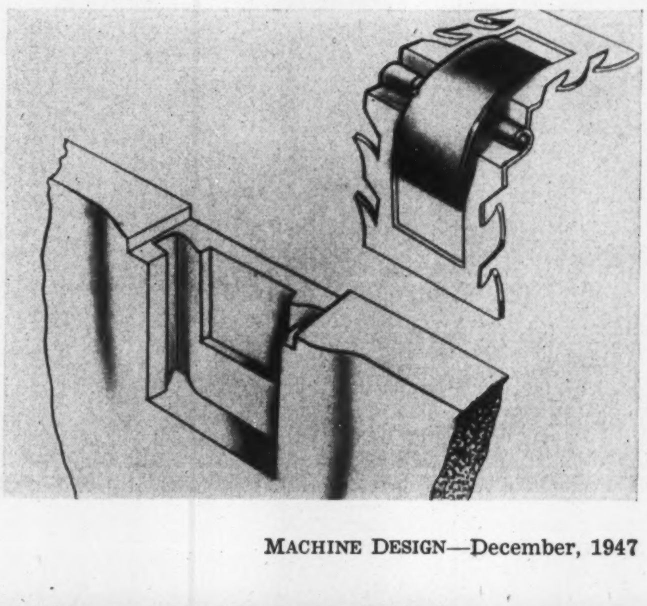

Ratchet wheel
Pawl
Limit switches
Gear and pawl fixed together
Link switch
Gear and ratchet wheel keyed together on shaft

Scanning THE FIELD for Ideas

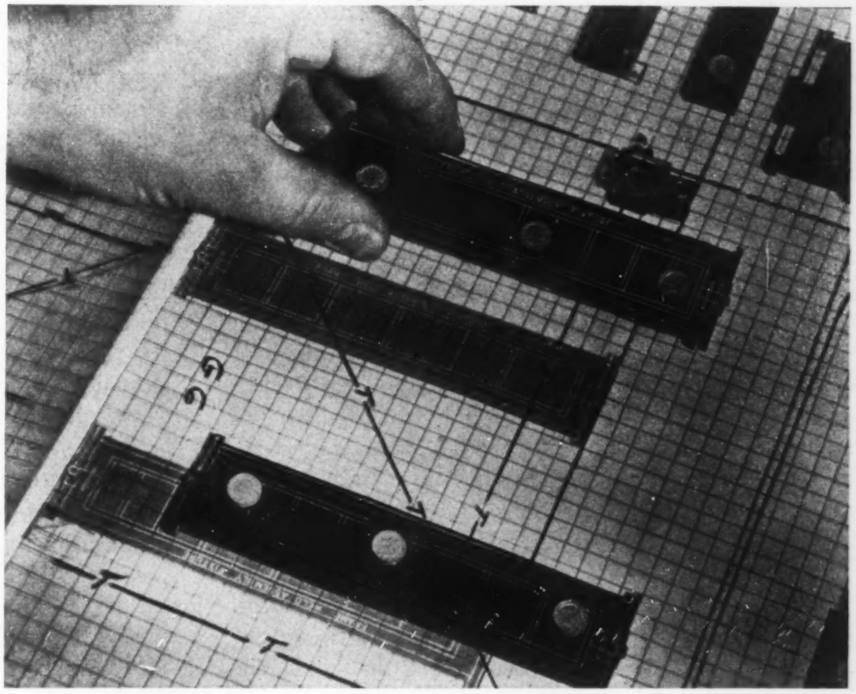


Transparent sighting fixture, above, eliminates costly cut-and-try procedure for locating hole positions on a complex casting. The first cut taken on a casting of this kind is of major importance, since it is subsequently used as a reference from which all other cuts and holes are located. It is necessary that holes be bored in the center of bosses and that other machined surfaces clean up. The transparent fixture, developed by the Moore Special Tool Co., contains bushings and sighting plugs corresponding to the correct locations of holes and machined surfaces. When the workpiece is inserted as shown, the sighting plugs are pushed against the casting and the eye can judge readily whether the piece is properly oriented. If not the reference cut can be repeated to correct it to the average of the errors in the casting. It is estimated that this method of checking the reference cut saves about eight hours of layout time on each casting in favor of 15 minutes of visual inspection.

Steel hinge, illustrated below, is designed with teeth that bite into slots molded into plastics housings, simplifying assembly operations. Developed by General Electric Plastics Division, it eliminates screws and rivets and incorporates a spring clip to provide snap action. This clip concentrates all the spring tension on the hinge itself, relieving strains on the plastics and thereby provides a stronger assembly. This type of hinge can be used



in either thermosetting or thermoplastic materials.



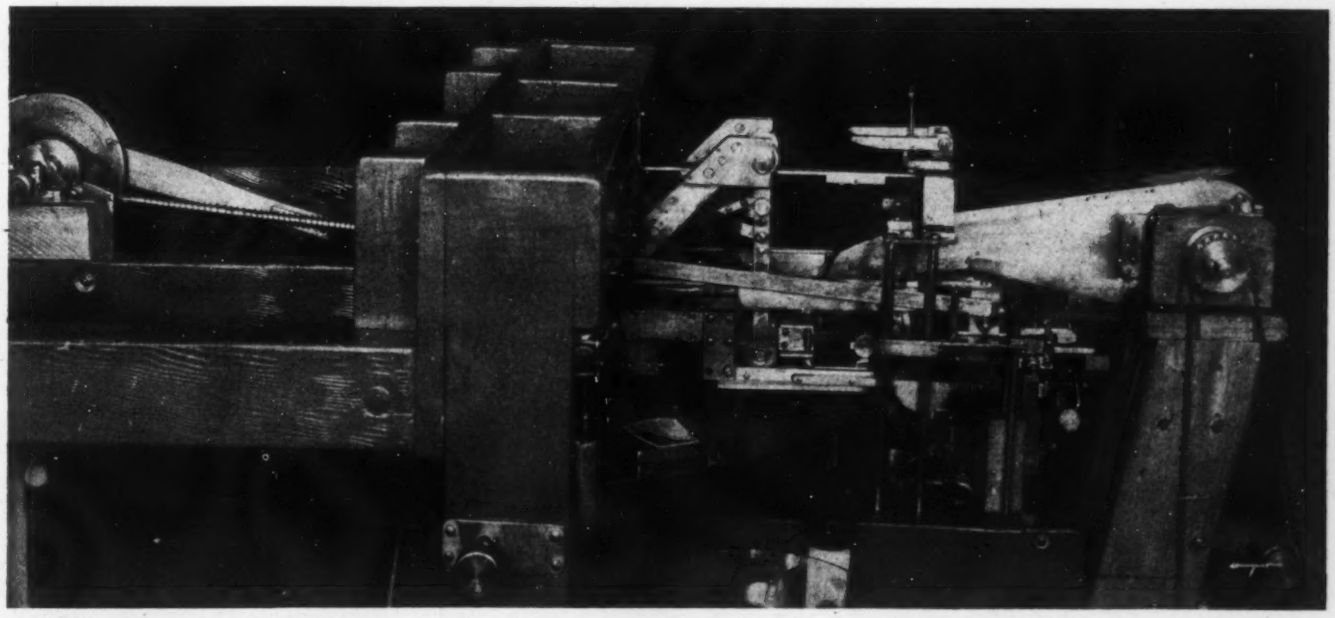
Templets, right, for standard equipment prove advantageous when arranging the position of component parts on a panel or in an enclosure, especially if space is at a premium. The technique, developed by John Hill Layouts for plant layout, appears to have possibilities for the designer who is confronted frequently with arrangements of the same components.

Templets are made from clear Plexiglas, coated on one side with a photographic emulsion. Scale drawings of the equipment are reproduced and developed as negatives on this emulsion. The outlines are then cut to exact shape from the sheet, giving an outline on black with identification marks and necessary data.

Small, circular Alnico magnets are inserted in holes in the templets and held in place with a piece of wire. When placed on a special printing paper, under which is a sheet of steel, the magnets hold the templets in any desired position. The paper is then exposed and developed, giving a positive print of the layout. The method saves considerable drafting time when alternative layouts are being considered.

Mechanical splitter, shown below, for producing thin films of mica promises to speed up the process considerably when compared to the tedious method of hand splitting commonly employed. Developed by D. W. Kessler and R. E. Anderson at the National Bureau of Standards, the model illustrated was built for small sizes of mica. Quality of the machine product compares favorably with that produced manually.

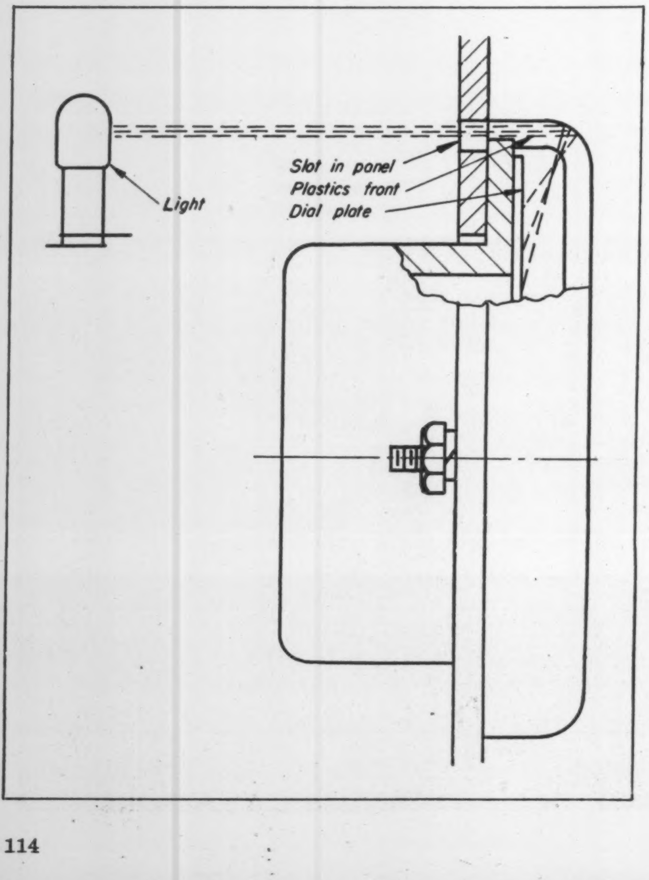
Six chucks, mounted around the periphery of the turntable, hold blocks of mica and each chuck is connected to a vacuum line as the turntable approaches the splitter station. The chucks slide forward about 1/4-inch to start the split. Thickness is gaged by two wheels which rest on the mica. When the splitter has raised a film of mica, the wheels are moved off to allow stripper knives to



pass between the film and block. Knives consist of spring steel, hinged at one end to oscillator shaft and thickened at the other by wedge-shaped pieces of brass.

Separated films are picked up by a conveyor. It consists of four idler pulleys and a drive pulley partially enclosed in a casing. The pulleys are perforated and carry a perforated belt. Suction through the shaft of the drive pulley draws the films to the belt. This conveyor is shown at the right side of the machine. Its assembly is hinged on the shaft of the drive pulley and swings through a small angle, the motion being obtained by cranks and rollers which are actuated by a cam on the carriage drive shaft. Split films occasionally vary in thickness as much as one-half mil, due to mica imperfections.

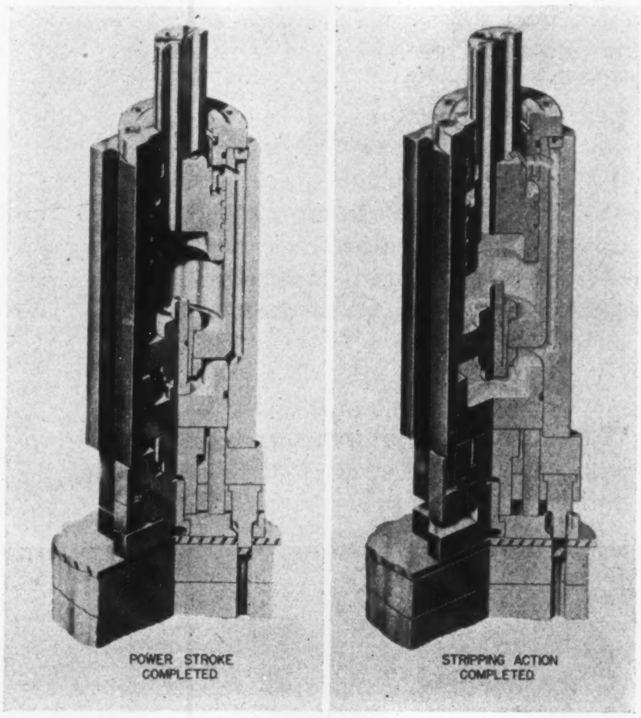
Indirect illumination for plastics-front instruments, of the type illustrated in the sketch below, gives especially soft and pleasing lighting effects. Light directed on the back of the case is "piped" through the clear plastics and diffused over the front and dial, one hole in the mounting panel permitting light to reach the back of the case. The bulb is mounted outside the case and sufficiently far away so that its heat will have no effect on the instrument. Size and type of bulb are determined by the amount of light desired and by the type of mounting, in this novel design by Assembly Products Inc.



Automatic hydraulic stripping on piercing unit, illustrated below, eliminates the conventional type of spring strippers, simplifying the mounting of punches and stripper plates. Designed by Mueller Engineering Co., the cylinder is carburized, hardened, and ground alloy steel. The power piston is held stationary and the cylinder body acts as a crosshead slide which assures rigidity and alignment of punches and dies. Illustrated at left below, is the completed power stroke, showing the relative position of punch and hydraulic stripper. At right below is shown the relative position of punch and stripper after completion of the stripping cycle and at start of return movement.

High and low-pressure hydraulic power units are used for the supply source. Equally satisfactory performance may be obtained, however, with a standard single-pump unit. Hydraulic circuit is identical to that of a standard double-acting cylinder.

When the fluid under pressure is admitted to the forward port of the cylinder, the slide advances under low pressure until the work is contacted. Then the high-pressure fluid is admitted to perform the actual punching operation. Cycle is then reversed, causing the punch to be withdrawn from the work while the hydrostatically actuated stripper plate holds the part firmly against the die block. Simultaneously the slide returns to its starting position. In tests 9/16-inch steel plates and 3/8-inch spring steel stock have been punched with 3/8-inch diameter punches. Action of the hydraulic unit is both powerful and smooth.



Specifying for Economy in Springs

By Ronald F. Pond
Spring Engineer
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Part II

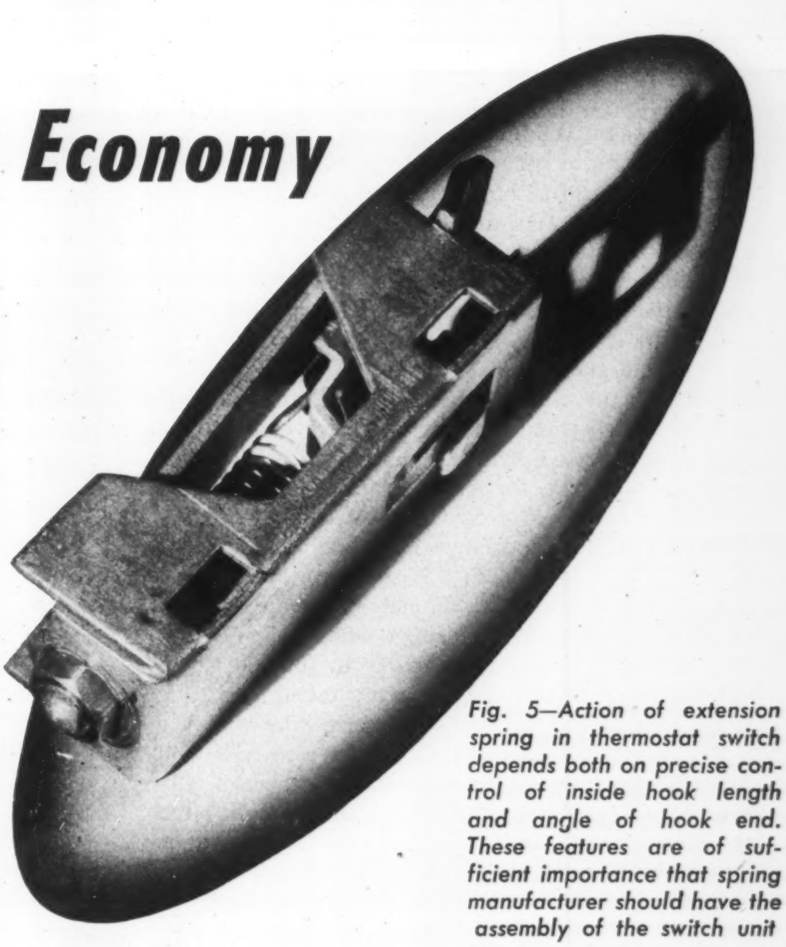


Fig. 5—Action of extension spring in thermostat switch depends both on precise control of inside hook length and angle of hook end. These features are of sufficient importance that spring manufacturer should have the assembly of the switch unit

SPECIFICATION of design details for mechanical springs requires a fundamental understanding of manufacturing processes in order to obtain both the most economical springs and low-cost assemblies. These considerations were discussed generally in Part I as they apply to all types of springs. This article will be devoted to particular aspects of the subject with respect to compression, extension, torsion, and other types of springs. Typical of the design problems involved is the assembly shown in *Fig.* 5 where the shape of an extension-spring end determines the operating characteristics of a snap-action switch.

Compression Springs

At first glance, it would seem a simple matter to furnish space information covering a compression spring application. In current practice, the designer almost invariably states the free length and the outer or inner diameter, or perhaps all three, which he has calculated. In many instances he furnishes also the diameter of the rod over which the spring is to work, or the diameter of the retaining hole for the spring. But there are many cases where the hole and rod diameters do not allow sufficient space for the most economical wire size, and the reasons for the shortage of space are often far from apparent.

Difficulty in fitting a compression spring inside a hole and over a rod generally centers in the fact that in all compression springs with normal or large pitch the active coils expand appreciably (increase in diameter) as the spring is compressed. In springs wound on an arbor, all coils have practically the same diameter in free position, but the active coils become larger than the end coils (where a spring has squared, or squared and ground ends) as the spring

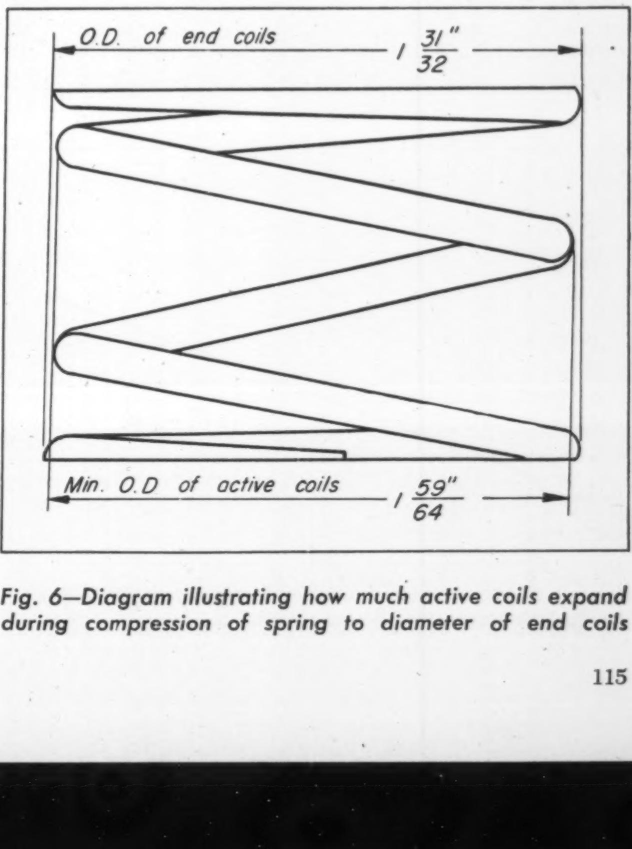

O.D. of end coils $1\frac{31}{32}''$
Min. O.D of active coils $1\frac{59}{64}''$

Fig. 6—Diagram illustrating how much active coils expand during compression of spring to diameter of end coils

is compressed. In squared-end springs made on automatic coilers—easily 90 per cent of all compression springs made in the United States—the end coils are larger than the active coils, in free position. When the spring is compressed to its solid height the active coils expand to approximately the diameter of the end coils. *Fig.* 6, a drawing of an actual spring, illustrates this fact.

The space required by a squared-end compression spring between a hole diameter and a rod diameter is, therefore, two wire sizes plus a practical manufacturing tolerance (see TABLES I, II, III and IV), plus an allowance for clearance, plus the amount of expansion which will occur in the active coils as the spring is compressed. This expansion per inch of coil *OD* will be called Factor *X*. The data in TABLES I, II, and IV are based on tolerances set by the Spring Manufacturers' Association.

Values of Factor *X* in *Fig.* 7, are based on a study of end and active-coil diameter differences in squared-end compression springs which have maximum pitch (a fiber stress range from 160,000 psi to 330,000 psi was considered). Factors taken from this chart, which should be applied as percentages to the *OD,* will result in allowances for differences in coil diameters which will be ample for most cases. Obviously, if a spring is designed with a small pitch (low fiber stress at solid height), its free length is comparable to a partially·compressed length of the same spring with maximum pitch, and therefore much less difference between active and end coil diameters will be observed than would be calculated by use of the factors taken from the chart. It must be emphasized that, because of the various design elements which have an effect on end and active coil diameter differences, the engineer should regard this chart as an aid, but not as a precision tool.

In the foregoing, operating space has been discussed with the idea of space for free movement and avoidance of wear being implicit. There is another angle in this business of fit in compression springs which is not always thoroughly understood. In numerous cases, a compression spring must furnish a snug fit on a mating part. An end coil, for instance, must assemble so as to grip firmly a washer or stud, the requirement being dictated because it would facilitate assembly, etc. Often in such cases, the specifications include a close tolerance on the *ID* of the spring and no further information whatever. No purchaser—omitting specific mention of the gripping action required and dimensions of the part to be thus held—should be surprised to find that the end coils of the spring received are 0.010 to 0.015-inch too large to do their holding job, though the active coils of the spring would be held nicely within standard tolerance limits.

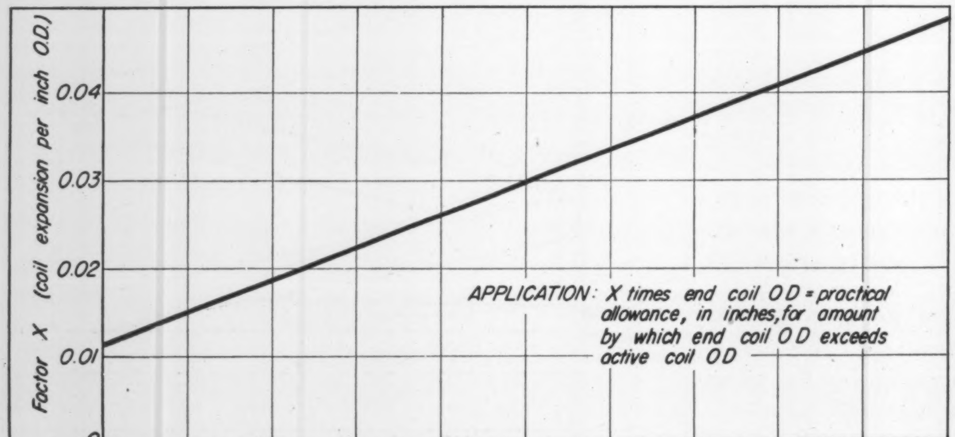
Tapered compression springs, having one end fitting over one mating part and the other end inside a second part, offer a parallel example. The only safe solution for specification lies in providing in the drawing the outlines and dimensions of the significant surfaces.

When the engineer considers his load and deflection specifications, and their relation to spring economy, he should deal first of all with that point which causes more trouble than any other single item: The matter of minimum deflected height. This is mentioned on relatively few drawings, yet it is one of the most critical specifications, from both the standpoint of spring service and spring cost.

To illustrate as briefly as possible: A spring 3 inches long is required to carry 10 pounds at a height of 2 inches, and to be "free from set." Assuming a solid height of ⅞ inch and a corrected fiber stress at that height of 180,000 psi, the spring manufacturer would use music wire, removing set by a pressing operation so that the spring would be capable of compression to its solid height without loss of load or free length.

Supposing that after having paid a high price for this spring, the buyer divulges the information that the spring is never compressed below the height of 1⅞ inch. The spring company engineers find that the corrected fiber stress at 1⅞-inch length is 78,000 psi. Job specifications are then changed to call for the use of a cheaper spring wire (hard drawn, for instance), the setting (pressing) procedure is omitted, and the buyer ends up paying 1/3 the former price for the revised spring.

Next in importance to minimum deflected height is data concerning solid height. If a spring is to be subject to deflection to solid, no matter what that



APPLICATION: X times end coil O D = practical allowance, in inches, for amount by which end coil O D exceeds active coil O D

Fig. 7—Factor for difference between end-coil diameter and active-coil diameter per inch of diameter for squared-end compression springs

height is (as in the case of certain valve springs subject to surge), it should be stated. But the design engineer should consider carefully before he sets up as inflexible practice the stating of solid height as nothing more than the result of the multiplication of the number of wire sizes times the wire diameter. Best practice dictates the relating of solid to minimum deflected height, stating a maximum solid height just far enough under minimum deflected height to avoid danger of coil clash.

In specifying materials for compression springs it should be remembered that it is easier to substitute various sizes and kinds of wire in compression springs than in any other type. For its validity this statement depends on the various cases where space is not closely restricted and where load deflection requirements are precisely stated. Given the computed data and complete space information plus authority to revise materials specifications the spring manufacturer will be in a position to produce a better design, or perhaps one facilitating delivery.

Methods of Specification

Three methods are current in specifying the number of coils in compression springs: (1) Stating the number of coils per inch, (2) Giving the pitch, i.e., coil center to coil center, not the space between coils, and (3) Stating simply the total number of coils or the number of active coils. While a satisfactory meeting of minds usually takes place regardless of the method used, seeds of costly trouble exist in the first two methods.

Unfortunately, yet another method of denoting the number of coils is used occasionally. It is merely supplying a drawing of the spring and expecting the manufacturer to count the coils. The only safe rule, in all phases of spring specifications, is to state the requirements wherever possible in words and figures, in the clearest possible manner.

In the specifying of ends for compression springs, it is becoming apparent to engineers that compression springs can often do their jobs perfectly well if not ground. Particularly in springs made of the smaller wire sizes, there is no easier way to halve spring cost. Any appearances of simplicity in this subject, however, are deceptive. If a spring has a fairly close working fit over a rod or in a hole, plain ends or squared only ends should serve satisfactorily providing none of the following conditions interfere:

1. Where a spring is extremely active, wear at the ends and on the sides as a result of buckling and cocking can be expected to cause failure.
2. Where solid height must be kept at a minimum. (Solid height of a spring with ground ends is calculated as the number of total coils times the wire diameter. when ends are not ground, solid height equals the number of total coils times the wire diameter, plus one wire diameter).
3. Where it is desired to hold a close load tolerance, squaring plus end grinding is often a practical necessity. The unavoidable variation in free length in springs as they come from the automatic coiler can be partially corrected by the spring end-grinding operation. This point applies especially in cases of short springs with small index, where the load rate is very high. For instance, if a load rate is 500 lb per inch of deflection, a variance of plus or minus 0.030-inch in free length will cause a load variation of plus or minus 15 lb. This load variance, therefore, can be materially reduced if, by end grinding, the free-length variation can be reduced to plus or minus 0.010-inch.

TABLE I

Manufacturing Variations for Spring Diameters

Coil Diameter (inch)	Plus or Minus Variations in Diameter*		
	D/d = 3 to 6	D/d = 7 to 10	D/d = 10 to 12
	(inch)	(inch)	(inch)
⅛	0.0020	0.0030	0.0045
⅛ to 3/16	0.0030	0.0045	0.0060
3/16 to ¼	0.0045	0.0060	0.0080
¼ to ⅜	0.0060	0.0080	0.0100
⅜ to ½	0.0080	0.0100	0.0125
½ to ¾	0.0100	0.0125	0.0150
¾ to 1	0.0125	0.0150	0.0225
1 to 1½	0.0150	0.0225	0.0313
1½ to 2	0.0225	0.0313	0.0470
2 to 3	0.0470	0.0625	0.0938
3 to 4	0.0625	0.0938	0.1250
4 to 5	0.0937	0.1250	0.1560

*Spring Index = D/d.

TABLE II

Tolerances for Spring-Wire Diameters

Wire Diameter	Tolerance
(inch)	(inch)
up to 0.016	+0.00025
0.017–0.062	+0.0005
0.063–0.080	+0.0010
0.082–0.104	±0.0010
0.105–0.144	±0.0015
0.145 and up	±0.0020

TABLE III

Variations in Spring Length

Based on unfinished, not ground springs

Number of Coils per inch	Length Variations per Inch of Spring*		
	D/d = 3 to 6	D/d = 7 to 10	D/d = 10 to 12
	(inch)	(inch)	(inch)
5	±0.020	±0.030	±0.040
10	±0.030	±0.040	±0.050
15	±0.040	±0.050	±0.060
20	±0.050	±0.060	±0.070

*Spring Index = D/d.

TABLE IV

Variations in Squareness for Ground-End Springs*

Number of Coils per inch	Squareness Variations for Ends		
	D/d = 3 to 6	D/d = 7 to 10	D/d = 10 to 12
	(deg)	(deg)	(deg)
5	1½ to 3	2 to 4	2½ to 5
10	2 to 4	2½ to 5	3 to 6
15	2½ to 5	3 to 6	3½ to 7
20	3 to 6	3½ to 7	4 to 8

4. Where the wire size is over 0.09375-inch an unground end is apt not to seat steadily enough for many applications, unless diameter of the coil is large.

Though the cheapest type of compression spring to

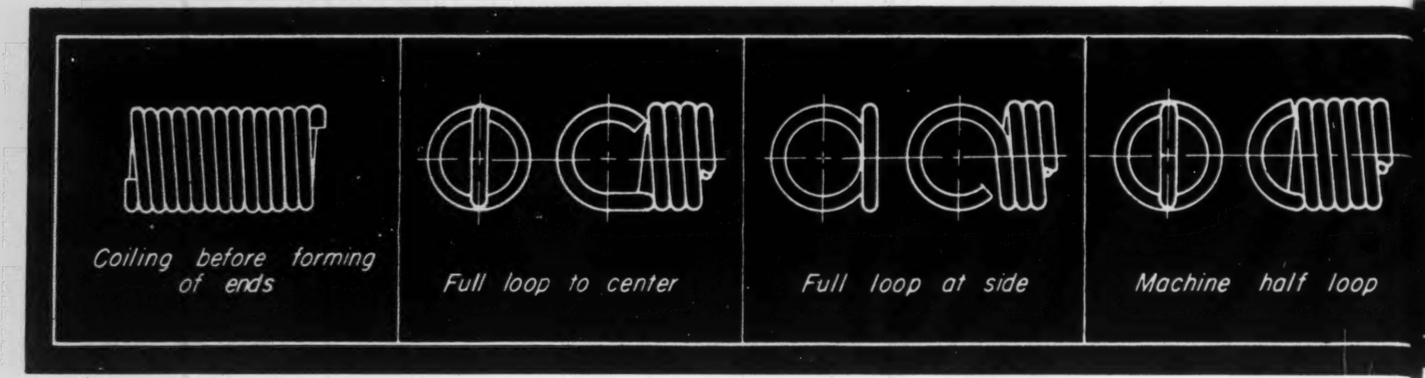


Fig. 8—Economical loops for extension springs arranged in order of ease of production

buy, "plain-end" springs have one shortcoming which develops whenever their index is large: They tangle and the time consumed in untangling them at the assembly line can easily offset their original price advantage. In such cases, the specifying of "squared ends only" will often help greatly, and add little more to the price than the cost of the material in the end coils.

A summary of the above "end" points is perhaps in order. The necessity for the neatness of fit to be obtained through the specifying of "squared and ground" ends should always be weighed against the added cost of grinding, and the decision should rest on whether or not the slight unsteadiness of a "squared only" or "plain" end will be a source of trouble through excessive wear and binding, or whether the larger length tolerances necessary in unground springs will make impossible the close load tolerances required by a particular application.

Extension Springs

The first suggestion which can be made to a cost-minded engineer considering use of an extension spring is to use a compression spring or possibly a simple torsion spring instead. By this observation there is no intention to infer that the extension spring should be shunned at all costs. It merely points to the fact that the average, simple extension spring is more expensive, load-pound for load-pound, than are average, simple compression and torsion springs. The reason for this situation resides in the fact that in a great many cases compression springs with unground ends and torsion springs with straight arms, and even with certain simple bends, can be made complete on automatic machinery. Extension springs, however, can be so made only in a very few cases. The cost of the additional operations required to form the end hooks or loops is generally larger than the initial cost of coiling the spring on an automatic.

While the engineer may find few cases where any two of these three types of springs can be used with equal ease, such cases do occur, and should have careful attention.

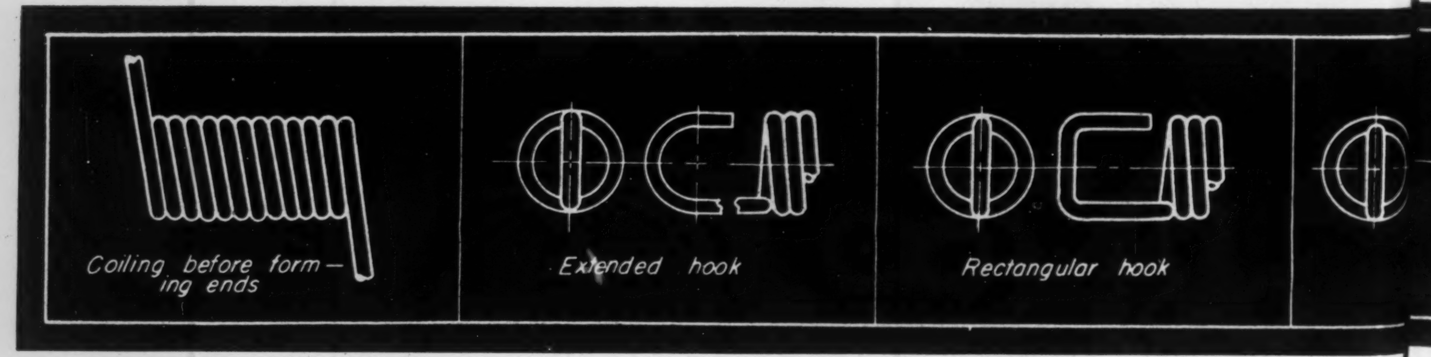
Specifying Space Information

In the furnishing of space information in extension-spring applications the engineer needs to consider a great many different angles, few of which can be handled adequately in this discussion. Those details which follow have been selected because they touch on points which appear to be the most troublesome.

Since few extension springs are closely confined in a hole, and almost never work over a rod, the close tolerances on the diameter which sometimes appear on drawings should be explained carefully.

In specifying free lengths, the best dimension to use is the inside hook length, or what could be called the bearing-to-bearing length. The coil length (number of coils times the wire size, plus one wire size) sometimes matters, because of adjacent parts. Never, if a good fit is desired, should coil length alone be depended upon and never should an extension spring

Fig. 9—Somewhat more expensive end loops than shown in Fig. 8. Whether or not these hook styles can be made with the minimum number of additional operations depends on numerous factors. Often springs with more than 35 coils and very long ends will cost a great deal more than springs with moderate proportions and the same style ends. These styles should be avoided wherever possible



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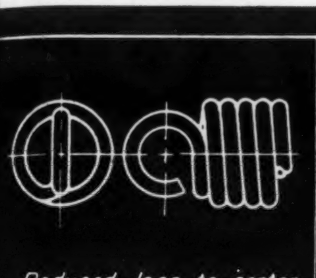
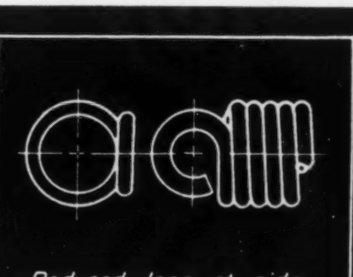

Reduced loop to center


Reduced loop at side

length be stated without identifying it exactly as overall, inside hook, center-to-center, etc.

One point more about length: Unless a mechanism demands that there be a position in which the extension spring must exert no tension on the affected parts, its free length and loading should be so arranged that the spring will be under some amount of extension while in the fully retracted position in the mechanism. While this advice is not a must, following this policy will prevent coil clash, particularly dangerous in springs of small index, and result generally in a better working unit.

In calculating and specifying loads and deflection of extension springs the engineer has to deal with the factor of initial tension, sometimes erroneously termed preload. Something like 20 per cent of all currently circulating drawings of extension springs make no reference either to initial, or to load requirements. For instance, an extension spring may have a potential safe load of 25 pounds, and an indicated rate of 5 pounds per inch of deflection. Since normal initial ranges between 15 per cent and 25 per cent of the potential safe load, depending on the spring index, the initial tension for the spring in question could be 5 pounds. Therefore, the spring manufacturer could furnish the spring with 5 pounds initial, which with a 5 pound per inch spring rate, would result in a load under 1 inch extension of 10 pounds, and 15 pounds under 2 inch extension. The designer, however, may have planned his loads to be as much as 5 pounds lighter.

The effect of initial on price, though minor, exists and has various angles. In the case of springs so large they must be wound on an arbor (this condition applies most often when wire sizes range from ¼-inch and upward) it is often more difficult to fur-

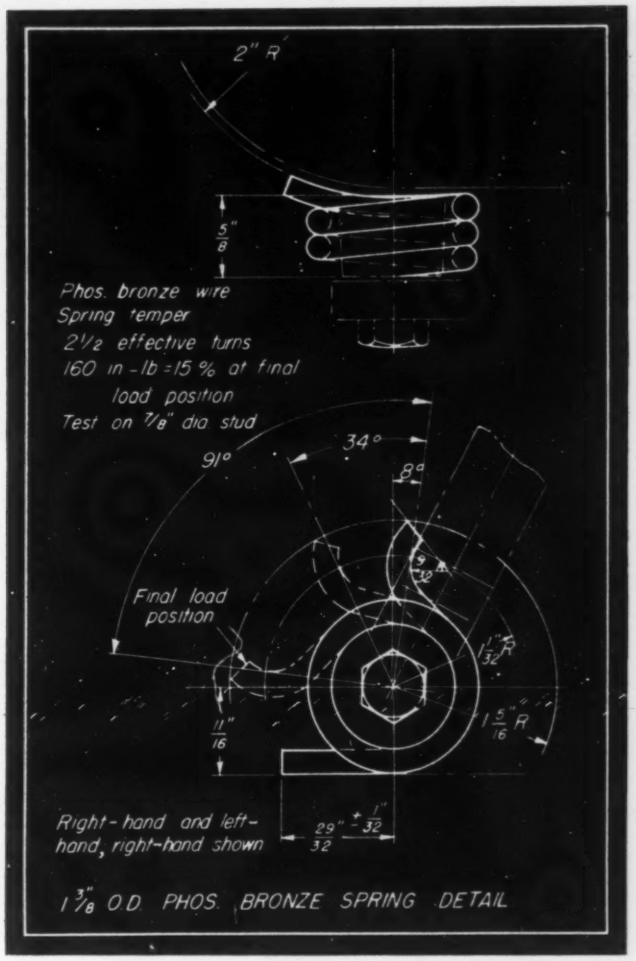
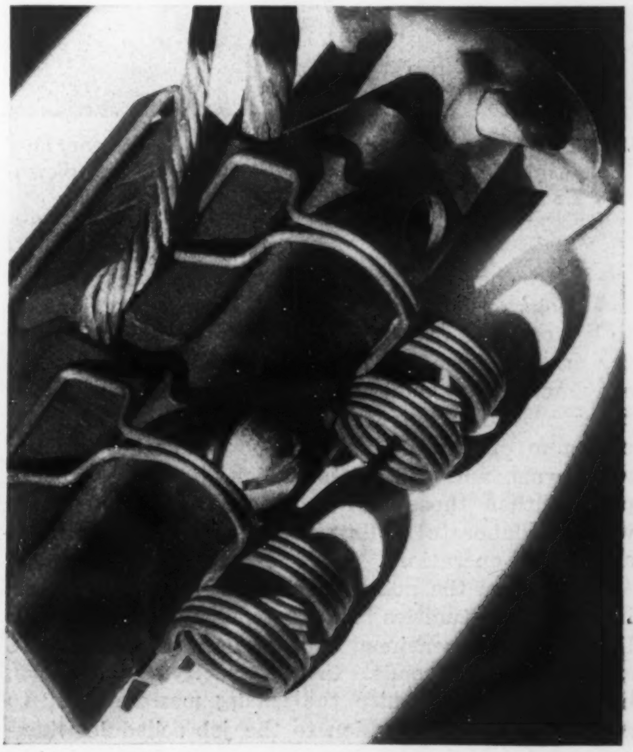
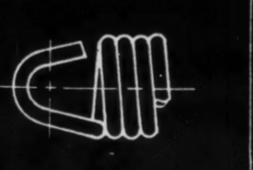
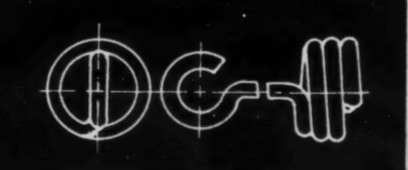


Fig. 10—Above—Showing adjacent parts in spring assembly and spring positions is recommended specification method

Fig. 11—Below—Double torsion springs for brush holder. Axis of springs and rectangular ends must be perpendicular to the spring arms, otherwise brushes would bind




Dobby hook


Hook extended from center

nish the springs without initial than with full initial. Therefore, such springs will be less expensive if designed with initial. There is a tendency for extension springs in all sizes to be a little lower in price when wound with normal initial, simply because they are often a little easier to coil and handle during subsequent operations. The principal point to consider, however, is that either very slight or very high initial often requires longer set-up time, and slower coiling speeds, with their adverse effects on price.

In the design of the end hooks or loops, the engineer has a chance to reduce costs. Fancy ends obviously require special tooling and extra operations which can easily increase the cost of the springs as much as 2c each, even in large volume production. If a complicated end, with close-tolerance dimensions, will make possible large savings in the overall cost of the assembly, it is justified.

But even in the simple appearing end jobs, there are many chances to reduce costs. Wherever possible, the hooks or loops should be of such proportions as to be formable from the ends of the coiling, which is the original form from which most extension springs are made. *Fig.* 8 shows such a coiling, and the various types of ends which can be made from it with the minimum of expense. *Fig.* 9 shows another coiling, with arms, and end types, which, though more expensive than those in *Fig.* 8, can usually be made without elaborate tooling and with the minimum of additional operations.

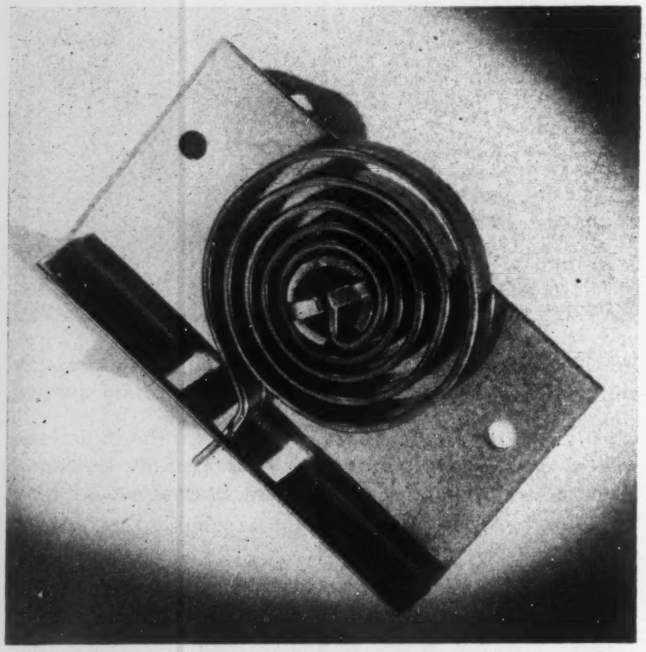


Fig. 12—Stainless steel flat coil hinge spring. Designer must know exact details of angular bearing position and dimensions of shaft as they affect inside end of spring

Aside from the points mentioned, the designer has his best opportunities to cut extension spring costs by limiting the dimensional and angular requirements of extension spring ends. In the specifying of hooks, he will usually require the spring manufacturer to add a trimming operation to the job schedule whenever he imposes a close dimensional tolerance on both hook openings and the angular relationship of the ends.

When specifying single and double loops, cost advantages may be derived by specifying only the minimum amount of coil in each loop. In extended hook specifications, the inside hook length should always be specified whenever space is required by an adjacent part. Showing the mating parts on the drawing is still better.

One final suggestion: If the designer cares to give the spring company responsibility as to satisfactory service of an extension spring, he should state exactly on his drawing the maximum length to which the spring must be extended without taking permanent set.

Torsion Springs

In most torsion spring applications, space is a simple matter. Usually, the torsion is assembled over a rod, the diameter of which is an item of critical information frequently omitted from drawings. In a few cases, also, torsion springs are partially confined in a hole, and since such cases are so rare as to be unsuspected without a direct reference, information about the hole diameter would be equally critical.

Torsion spring specifications also include numerous instances where arm positions are not identified as "free" or as under specific loads, and where direction of load and hand of coiling are omitted. It is elementary that load and deflection information should be furnished in terms of inch-pounds, at specific numbers of turns, or degrees of arm movement, and the point of load application should be shown in an unmistakable manner. As to load-testing, it should be avoided if possible, for this operation is more expensive in the case of torsion springs than in other springs. Direction of coiling should always be described in words, using the terms "right hand" or "left hand", determining the "hand" by the same method used for screw threads. Torsion springs, coiled in the wrong hand, are worthless.

Adjacent parts should be shown on the drawing of the spring (*Fig.* 10) or an assembly sent to the spring manufacturer, *Fig.* 11. Having such information, he may be able to suggest a change in length of an end to eliminate a trim operation, or a change in bends in another case. Without such information, he can do no more than follow the drawing, cost what it may.

There remain not discussed flat-coil torsion springs (*Fig.* 12), motor springs, flat springs, spring rings, coiling, etc. Both because of space, and because of the complexity of design and specifications, these families of springs can not be treated here separately. However, the majority of the statements already made apply equally to all. In several of these types, good drafting room practice will go a long way toward providing the correct specifications.

The foregoing discussions are intended as suggestions for a practical approach to the problem of designing and specifying springs, so that the twin objectives—the right spring and the right price—may be more easily achieved.

Simplified Analysis

. . . eliminates need for formal calculus. Graphical methods provide a practical solution to certain design problems where mathematical methods are inapplicable or too difficult

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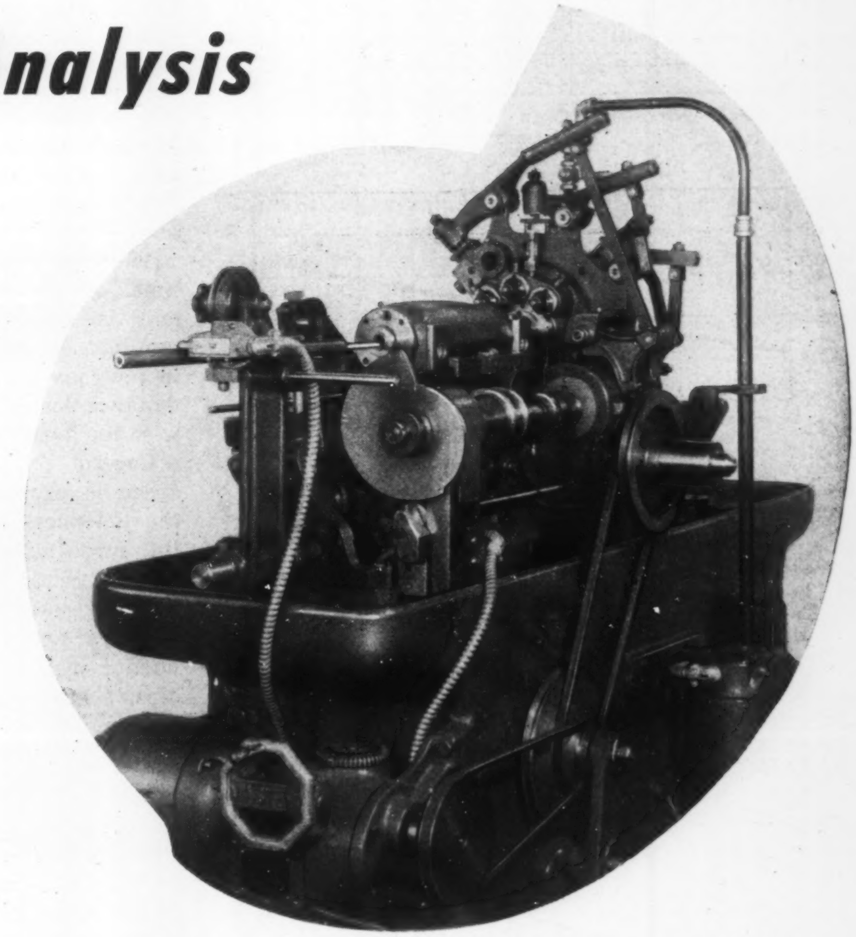


Fig. 1—Analysis of velocity and acceleration of cam profiles is easily performed by graphical differentiation

DESIGN problems involving application of the calculus occur often enough to be troublesome to engineers not well versed in the intricacies of this branch of mathematics While the proper use of differential and integral calculus leads to the fastest and most accurate solution of many problems, there are times when more laborious graphical methods are preferable. Sometimes the mathematical functions are so complex that analytical methods become too involved, or the function may not be readily expressible in mathematical terms, *Fig.* 1. Again, the graphical process automatically furnishes a visualization of the problem, permitting better understanding and facilitating checking of the results.

It is the purpose of this article to show engineers how to get usable results without recourse to the somewhat formidable mathematics of the calculus. Because the graphical methods discussed are actually the basis of the so-called "infinitesimal" calculus, they are fundamentally sound, the accuracy of the results depending only on the accuracy of the construction lines and measurements. However, it should be emphasized that these methods should be employed only when other methods of analysis have been fully considered. There are certain inherent characteristics which make it difficult to attain great accuracy, especially in differentiation, and the graphical constructions must be performed with extreme care.

Both the differential and the integral calculus are combined in what is known as the infinitesimal calculus, which is essentially the mathematical method which treats of the laws of continuously varying quantities. The integral calculus was an outcome of the methods used by the ancients to calculate areas bounded by curved lines. The curve was treated as being polygonal (bounded by a series of straight lines) and the area of the polygonal figure could be estimated by geometry. The greater the number and the shorter the individual length of the little straight lines representing the polygonal curve, the greater the accuracy. Similarly, a mathematician today estimating the length of an arc imagines the arc split up into infinitesimally small straight lines or elements. The sum of these elements approaches a limiting value as the elements are taken finer, and it is this limit which finally measures the length of the line, the process being called integration.

Differential calculus also deals with very small increments or elements. When a point traces out a

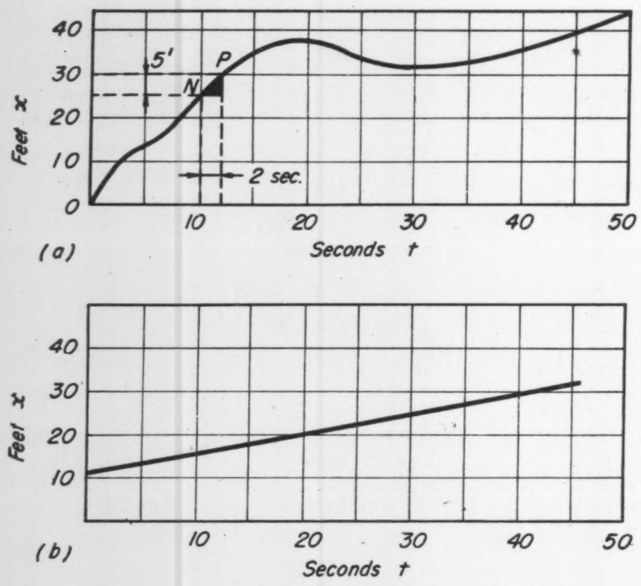
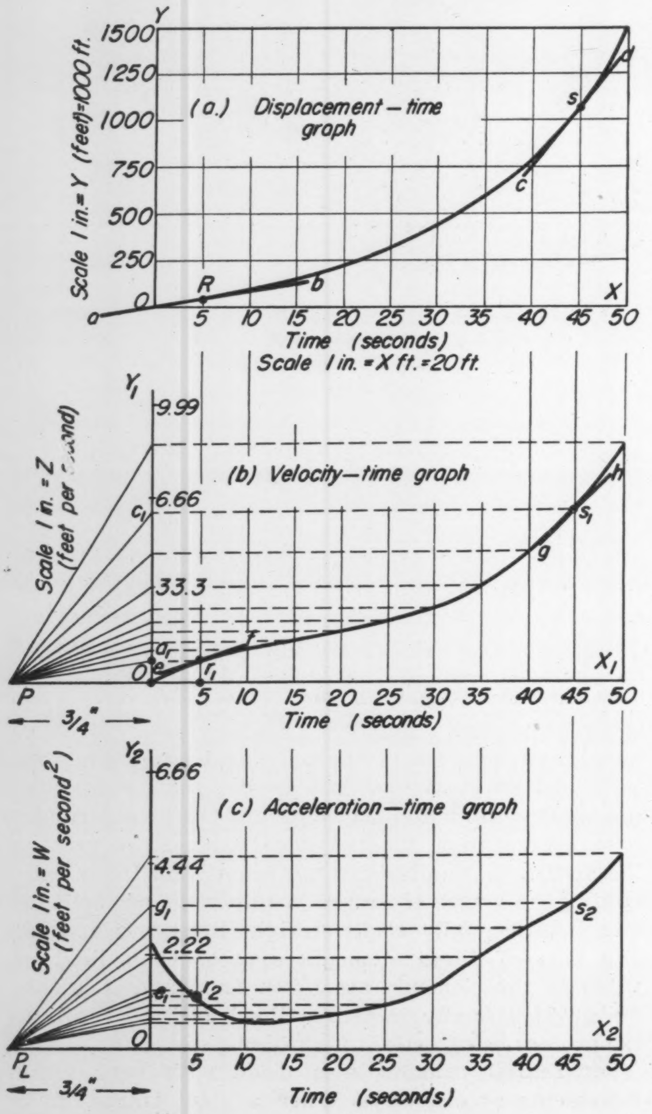


Fig. 2—Above—Variable velocity is indicated by distance-time curve (a), constant velocity by straight line (b)

Fig. 3—Below—How to construct velocity and acceleration curves from a displacement-time curve



curve it is clear that at any instant the point is actually moving in a line at a tangent to the curve. As the point describes the curve, its direction of motion is constantly changing and the change of direction of the tangent is a function of the arc or curve. Its rate of change per unit length of arc measures the curvature.

It is always possible to *differentiate* an expression and find its rate of change in terms of the variables used, but the inverse process of *integration* is possible only in a limited number of cases and thus does not always offer a ready mathematical solution.

The most common variable quantities are space and time. As an example, therefore, distance and time may be represented in a graphical fashion on the familiar cartesian co-ordinates, *Fig. 2a*. Obviously in the case illustrated the speed is not constant since distance does not increase uniformly with time; otherwise the graph would appear as in *Fig. 2b*.

Careful consideration of *Fig.* 2 will disclose that speed is proportional to the slope of the graph or the steepness at any point. Thus the steepness of the curve near point *P* can be found by selecting a short interval of time, say two seconds, and considering how much the curve rises for that time interval. Using x and t for distance and time respectively, change in $x = 5$ ft and change in $t = 2$ sec. Then steepness near *P* and between *NP* is

$$\frac{\text{Change in x}}{\text{Change in t}} = \frac{5}{2} = 2.5 \text{ ft per sec}$$

which is a velocity.

Thus the slope of the curve represents a velocity and the steeper the slope the greater the velocity. Mathematically, the "steepness" of the original *distance-time* curve is called the *first differential* curve of this original.

The ordinates of the first differential curve would, in this case, be plotted as feet per second against a base of time. Similarly it is possible to ascertain the slope of the *velocity-time* curve and the resultant curve of feet per second per second plotted against a base of time would be an *acceleration-time* curve or the *second differential* curve of the original distance-time curve.

So far the symbols of orthodox mathematics have been avoided. Two engineering examples, solved completely by graphical methods, will show more clearly than a wealth of description the ease of graphical treatment for the differentiation of related values on cartesian co-ordinates.

EXAMPLE I: A mine hoist is raised by an electric motor according to the displacement curve recorded in *Fig. 3a*. The linear distance moved by the elevator is plotted in feet, and the consecutive equal time intervals, *t*, in seconds. It is required to draw graphs of the velocity and acceleration of the lift cage.

SOLUTION: Drop suitable ordinates from curve, *Fig. 3a*, and erect axes OX_1, OY_1 and OX_2, OY_2. Take any pole *P* on OX_1 extended and draw Pa_1, parallel to *ab*, the tangent to curve *a* at *R*, to intersect axis OY_1 at a_1. Draw a line parallel to OX_1 from a_1 to cut the ordinate extended at r_1. Similarly for *S* on

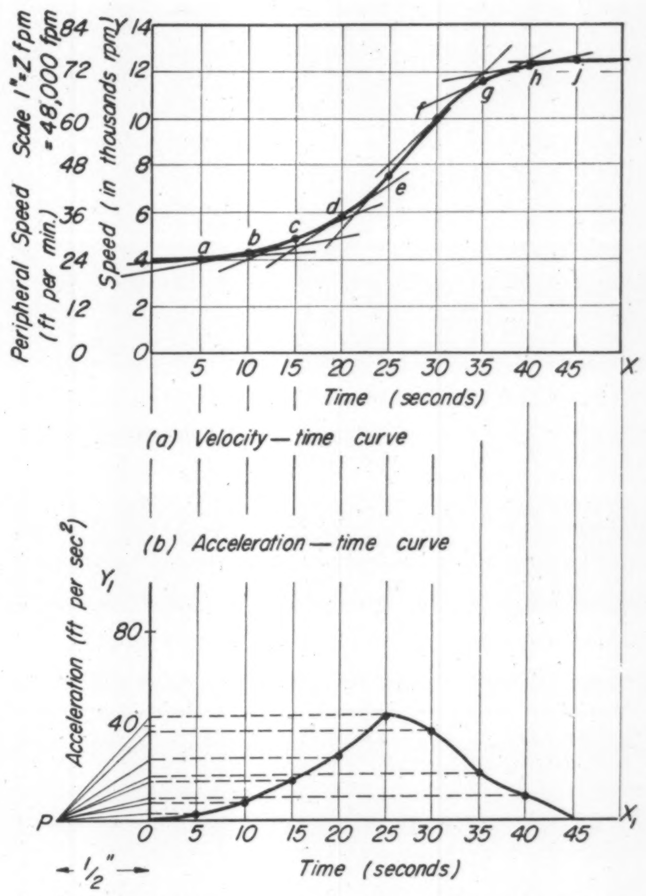


Fig. 4—Construction of an acceleration-time curve for a pulley based on tachometer and stopwatch observations

curve a, draw Pc_1 parallel to the tangent at S (cd), project c_1 to cut ordinate at S_1. Proceed for all other points on curve and finally draw velocity-time curve b as shown.

To obtain curve c take any pole P_2 on OX_2 extended and draw $P_2\, e_1$ parallel to ef, the tangent to curve b at r_1, project e_1 to cut ordinate at r_2. Proceed in similar fashion for such points as S_2 etc., and finally construct acceleration-time curve, c.

SCALE FOR VELOCITY-TIME CURVE: Velocity, being measured by the slope or steepness of the distance-time curve, is given by the slope of the line ab in *Fig. 3a* or Pa_1 in *Fig. 3b*. Change in distance corresponding to Pa_1 is $Oa_1 \times Y$ where Y is the distance scale, feet per inch. Corresponding change in time is $OP_1 \times X$ where X is the time scale, seconds per inch. Inasmuch as actual velocity v is distance change divided by the time change.

$$v = \frac{Oa_1 \times Y}{OP_1 \times X}$$

The velocity scale then is v/Oa_1 feet per second per inch or

$$Z = \frac{v}{Oa_1} = \frac{Y}{OP_1 \times X}$$

For the example in *Fig.* 3, $Y = 1000$ feet per inch; $X = 20$ seconds per inch; and $OP = 0.75$-inch. Therefore

$$Z = \frac{1000}{20 \times 0.75} = 66.7 \text{ ft per sec per inch}$$

SCALE FOR ACCELERATION-TIME CURVE: Acceleration = (velocity change) ÷ (time change), therefore

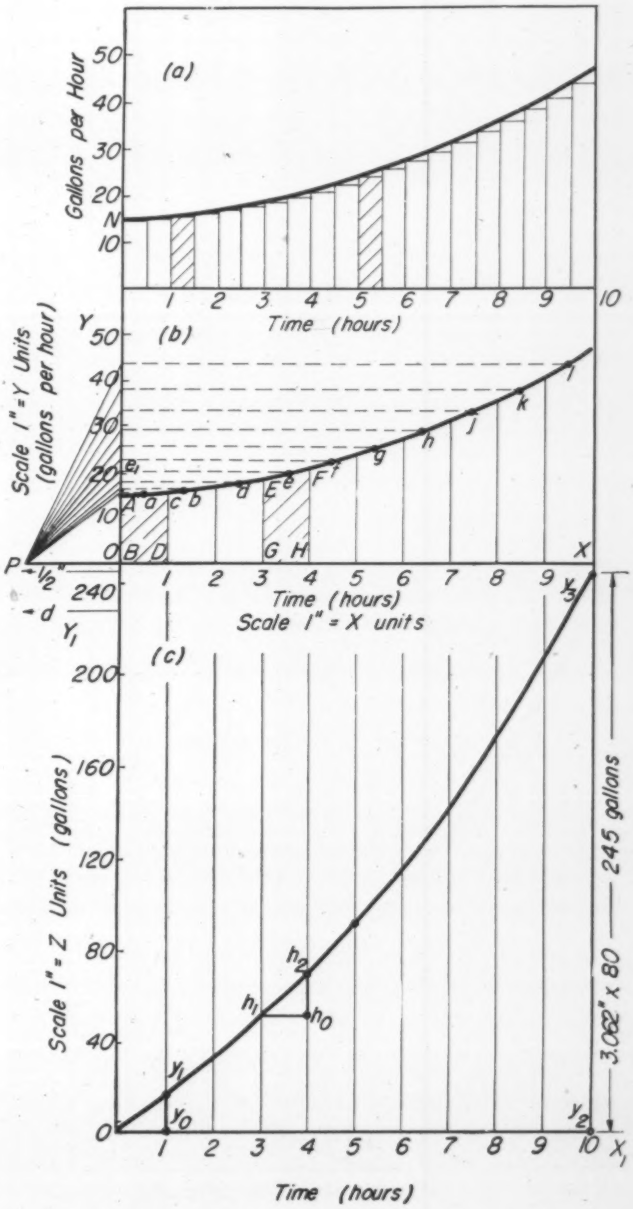
$$a = \frac{Z \times Oe_1}{X \times OP_2}$$

where a = actual acceleration, feet per second per second; y_2 = ordinate to acceleration curve, inches. The acceleration scale then is $W = a/y_2$ feet per second per inch, or

$$W = \frac{a}{y_2} = \frac{Z}{X \times OP_2}$$

For the example in *Fig.* 3, $Z = 66.7$ feet per second

Fig. 5—How to construct a quantity-time curve from observations of rate of flow and time



per inch, therefore

$$W = \frac{66.7}{20 \times 0.75} = 4.44 \text{ ft per sec}^2 \text{ per inch}$$

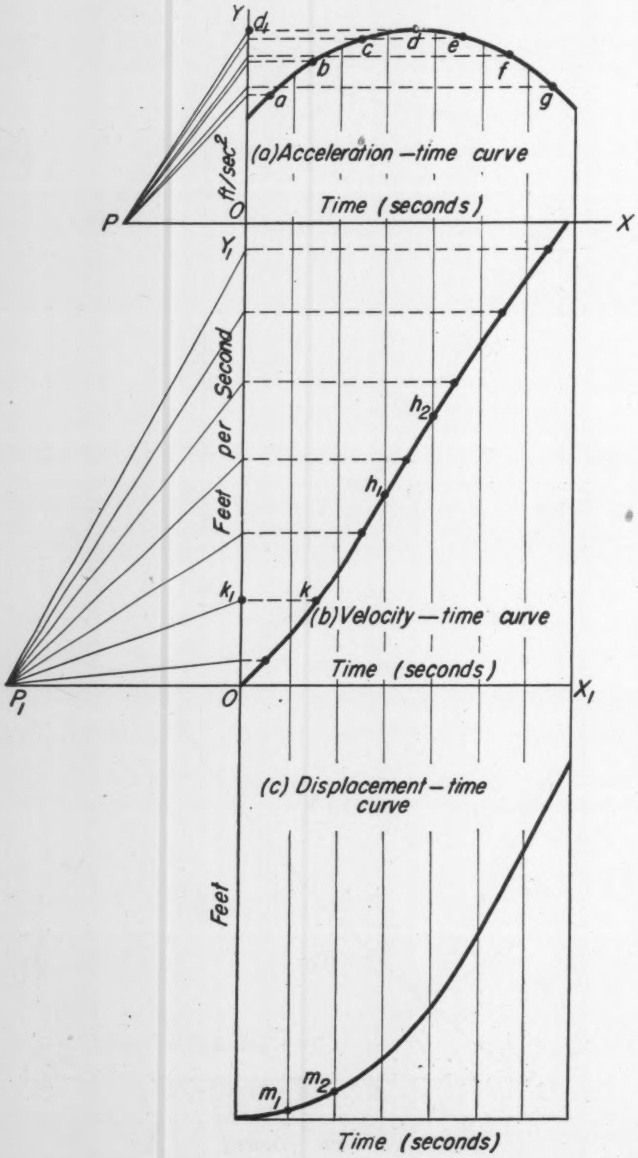
Example II: The velocity of a high-speed fabricated pulley, 23 inches in diameter, is constantly changing due to prime mover fluctuations under load. The designers are interested in the acceleration of this component. From a graph of rpm versus time, as plotted in *Fig.* 4*a*, it is required to draw a graph of acceleration.

In this example it will be noticed that only the second differentiation need be performed since the test instruments (tachometer and stop-watch) have furnished the first differential of the displacement.

Solution: Drop suitable ordinates from curve, *Fig.* 4*a*, at points *a, b, c, d, e, f,* etc. Draw tangents to curve at these points as shown.

Take any pole, P, on OX_1 produced and from P draw lines parallel to the tangents at *a, b, c, d, e, f,* etc. Where these lines cut the axis OY_1 draw lines parallel to axis OX_1 to cut ordinates produced. The acceleration-time curve is then drawn through the points.

Fig. 6—Double integration of acceleration-time curve gives curves of velocity and displacement



Acceleration Scale: As before, acceleration scale is

$$W = \frac{Z}{X \times OP}$$

As plotted the velocity scale is 1 inch = 8000 rpm. The corresponding linear velocity scale is 1 inch = $8000\ \pi d = 8000 \times \pi \times 23/12 = 48{,}000$ ft per min = 800 ft per sec. Also, $X = 20$ sec per inch and $OP = 0.5$-inch, therefore

$$W = \frac{800}{20 \times 0.5} = 80 \text{ ft per sec}^2 \text{ per inch}$$

Cam Design and Analysis: Further interesting examples of the use of the graphical method of differentiation are seen in the calculation of cam profiles, *Fig.* 1. When a displacement diagram showing the relation between cam motion and follower lift has been drawn it is possible, using the previous methods, to draw graphically the follower's velocity and acceleration curves, thus displaying any poor features of design.

Differences in cam profile not perceptible by visual comparison show up strongly in the velocity curve and even more so in the acceleration curve. Examples of this may be seen by referring to Machine Design, July, 1944, page 145 and July, 1947, page 143.

Integration, or the use of the integral calculus, is in reality the addition or summation of small quantities and a clear approach is provided by the polygonal methods of the ancients.

Example III: As a practical example of the use of integration by graphical methods, the result of a test on an oil pump is shown in *Fig.* 5. Over a period of time the flow of oil in gallons per hour is represented by the curve illustrated. It is required to find the quantity pumped after any elapsed time.

Solution: To find the total flow in the 10 hours of the test period it is necessary to integrate the curve, that is, to find the area under the line. To do this *Fig.* 5*a* could be split up into columns and the total flow will then be the sum of the areas of the individual columns drawn on the graph. However, this is only approximate because the flow is not constant for any interval, and to obtain an accurate answer it would be necessary to reduce the ½-hour spacings to as small a space as possible in each case, that is, reduce them to infinitesimal values of time.

Instead, the integration can be performed graphically by simply reversing the construction, already discussed, for differentiation. The diagrams, *Figs.* 5*b* and 5*c*, show this relatively simple flow-time curve treated graphically. The construction is as follows. From curve *b* drop suitable ordinates as shown and select midpoints *a, b, d, e, f,* etc. From these points draw lines parallel to OX cutting axis OY. Select any pole P on OX produced, and draw lines from P to meet the points of intersection of the horizontal lines on OY.

Draw axis OX_1 and axis OY_1. Then the slope of the curve c between any pair of ordinates is given by the appropriate radiating line from P. One detailed case will clarify this. Take point e on *Fig* 5*b*. Project this point to cut OY at e_1, draw Pe_1, then slope of required curve between ordinates h_1 and h_2 is given by Pe_1 hence the line h_1 h_2 is parallel to Pe_1. Proceed for all other points and the final curve is as shown in *Fig.* 5*c*.

The ordinates of *Fig.* 5*c* are a representation, to a scale, of the areas under the appropriate strips. For example the area *ABDC* in *Fig.* 5*b* is represented by ordinate y_0y_1 in *Fig.* 5*c*; similarly area *EGHF* is represented by ordinate h_0h_2.

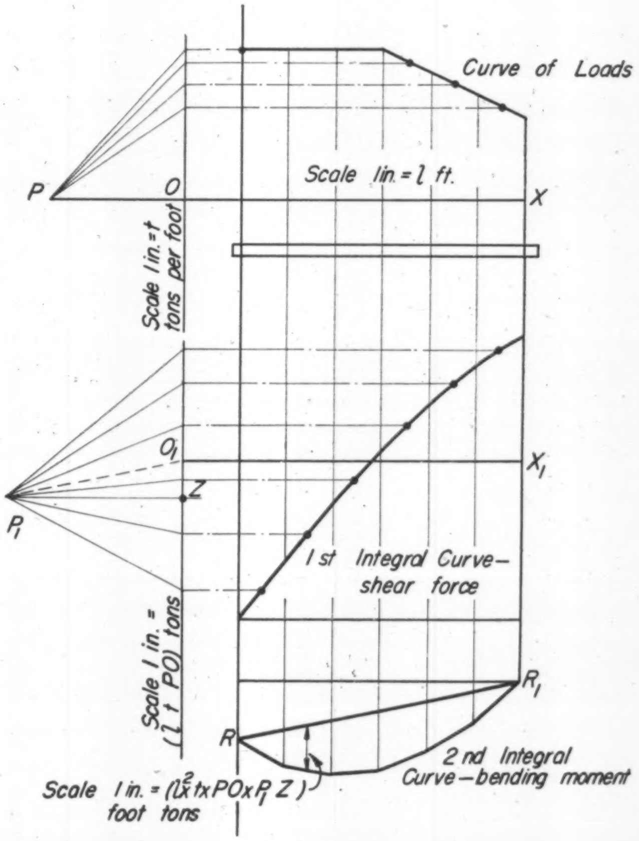

Curve of Loads
P
O
X
Scale 1in.= l ft.
Scale 1 in.=t tons per foot
O1
X1
Z
P1
1st Integral Curve—shear force
Scale 1 in.= (l t PO) tons
R
R1
2nd Integral Curve—bending moment
Scale 1 in. = (l² t x PO x P1 Z) foot tons

Fig. 7—Graphical double integration of beam load curve. Poles P and P_1 are arbitrarily selected. Shear force zero line O_1X_1 is located after the bending moment curve has been constructed, the line P_1O_1 being drawn parallel to RR_1, the zero line for the bending moment curve

To find the scale for the gallons-time curve, the flow in gallons corresponding to h_0h_2 therefore is

$$h_0h_2 \times Z = EGHF \times X \times Y$$

where X is the time scale, Y is the gallons per hour scale, and Z is the gallons scale, *Fig.* 5*c*. Then

$$Z = \frac{EGHF \times X \times Y}{h_0h_2} = \frac{h_1h_0 \times Oe_1 \times X \times Y}{h_0h_2}$$

inasmuch as area $EGHF = GH \times Oe_1 = h_1h_0 \times Oe_1$. Also, from similar triangles, $h_1h_0/h_0h_2 = PB/Oe_1$, therefore

$$Z = PB \times X \times Y$$

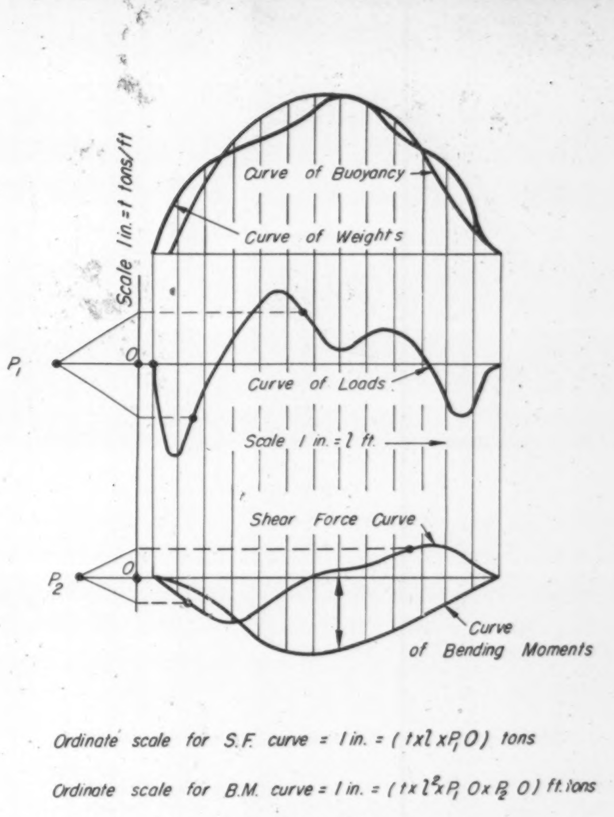

Scale 1in.=t tons/ft
Curve of Buoyancy
Curve of Weights
P1
O
Curve of Loads
Scale 1 in.= l ft.
Shear Force Curve
P2
O
Curve of Bending Moments
Ordinate scale for S.F. curve = 1 in. = (t x l x P1O) tons
Ordinate scale for B.M. curve = 1 in. = (t x l² x P1 O x P2 O) ft.tons

Fig. 8—Double integration of weight minus buoyancy curve gives bending moment at points along length of ship

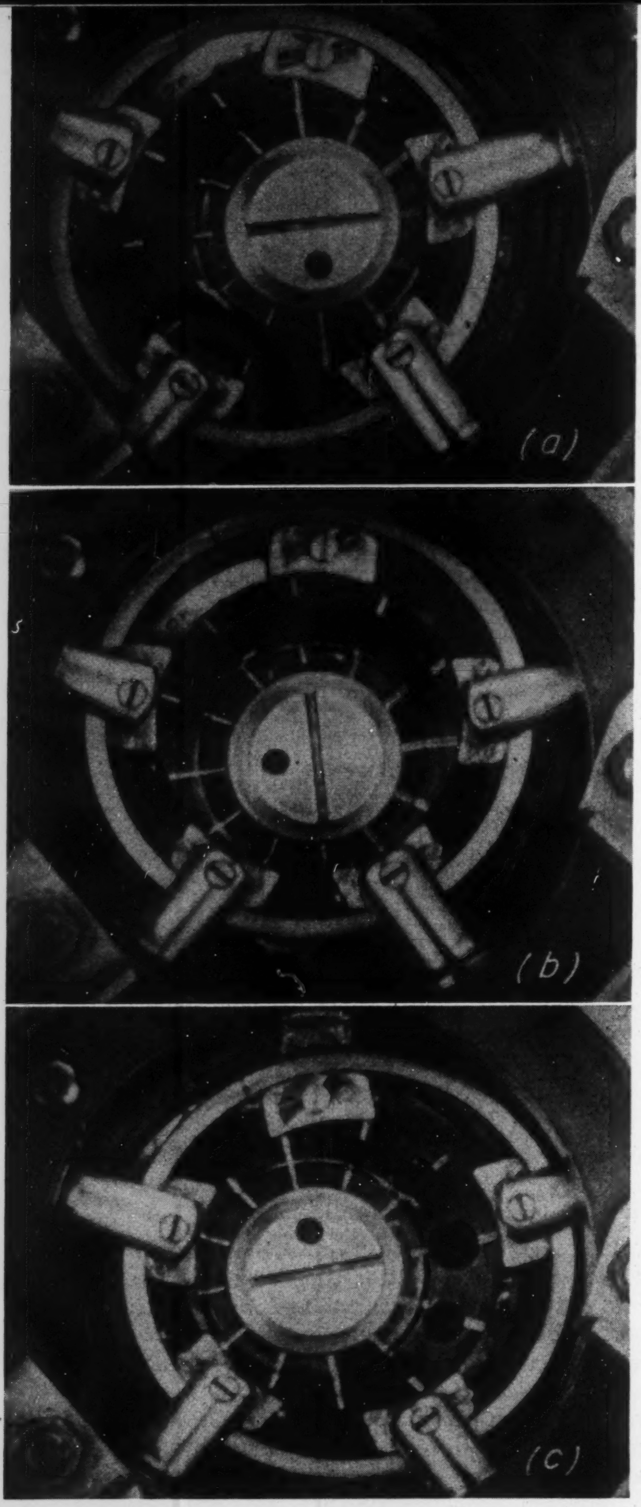
For the example in *Fig.* 5, $PB = ½$-inch, $X = 4$ hours per inch, and $Y = 40$ gallons per hour per inch, therefore

$$Z = ½ \times 4 \times 40 = 80 \text{ gallons per inch}$$

Total area under the curve is represented by the ordinate y_2y_3 which measures 3.06 in. Total flow therefore is $3.06 \times 80 = 245$ gallons.

INTEGRATION APPLICATIONS: Using a similar construction an acceleration-time curve can be changed into a velocity-time curve and a space-time curve, performing two complete integrations, *Fig.* 6. This is the exact opposite procedure to that discussed under differentiation. The use of first and second integral curves plays an important role in many fields of engineering design. Two examples will suffice to show the versatility of this method of working.

In beam problems the first integral curve can be used to give a curve of shear and the second integral curve a curve of bending moments. A typical problem set out and analyzed by the graphical method is shown in *Fig.* 7. Although this is a simple example the same procedure may be followed for more complex structures where the loading is of a very irregular character. For example, it is interesting to note that a ship is in effect a girder supported by pressure of the liquid medium and weighted along its entire length, *Fig.* 8. From the curves of weight and buoyancy a subtraction curve gives a curve of loads, and first and second integral curves will yield curve of shear and bending moments. Voltage drop problems in loaded electrical distributors are analogous to loaded beam problems in many ways and similar graphical methods have a bearing on their solution.



High-Speed Movie

By Sergei G. Guins*
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Acrotorque Co.
Stamford, Conn.

WHEN puzzling failures occur during the development of a new machine, the analysis and subsequent redesign often can be greatly aided by recourse to modern research equipment. A powerful tool, which is of particular value in the study of mechanisms, has for some time been available in high-speed motion pictures†, *Fig.* 1. How this technique was applied to a problem which defied a wholly analytical solution is discussed in this article.

In perfecting a high-pressure hydraulic transmission, the pump unit of which is illustrated in *Fig.* 2, particular importance was attached to the design of the valve operating mechanism. The first design, shown in *Figs.* 1 and 2, employed a connecting rod of the rocker type having its center of oscillation below the restraining ring. Although this proved quite satisfactory, it was felt that a better force relationship and a better arrangement of parts could be obtained with a design in which the center of oscillation of the connecting rod lay outside the restraining ring, as in the case of the main connecting rod, *Fig.* 2.

On this second design the bearing surfaces failed

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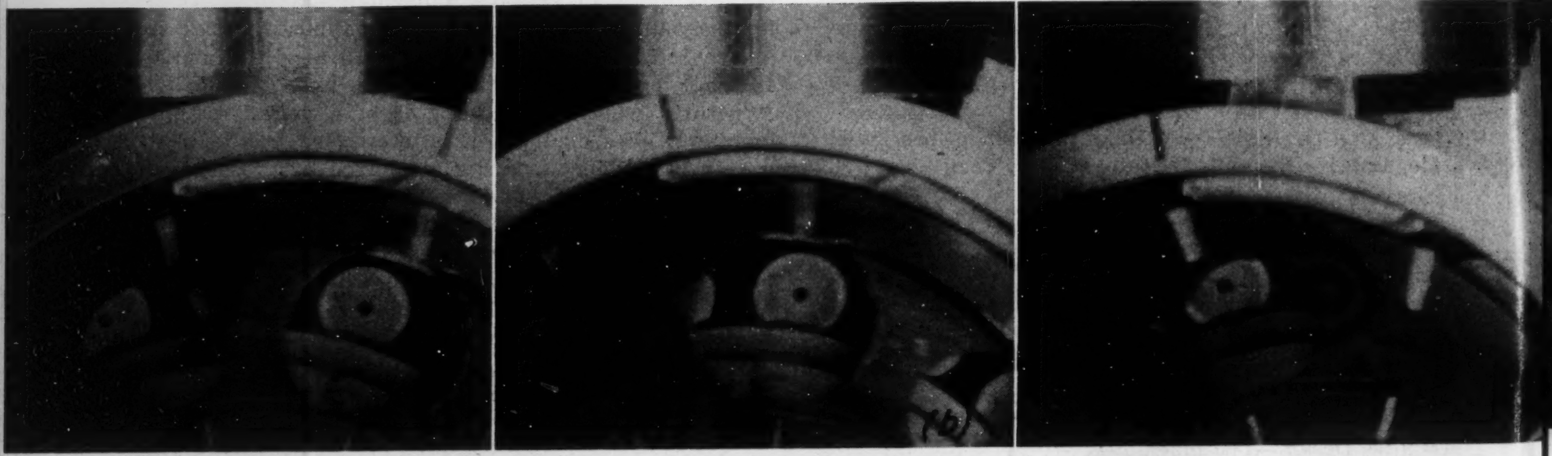
† "High-Speed Photography"—G. A. Hawkins and C. E. Balleisen, MACHINE DESIGN, Sept., 1947, Page 121.

Fig. 1—Left—Three stills from motion picture of rocker type connecting rod in operation. Connecting rod has no lateral motion and restraining ring does not rotate



Solves Tricky Problem

Fig. 2 — Right — Cross sections of Acrotorque pump unit showing main power piston assembly at left and valve mechanism assembly at right

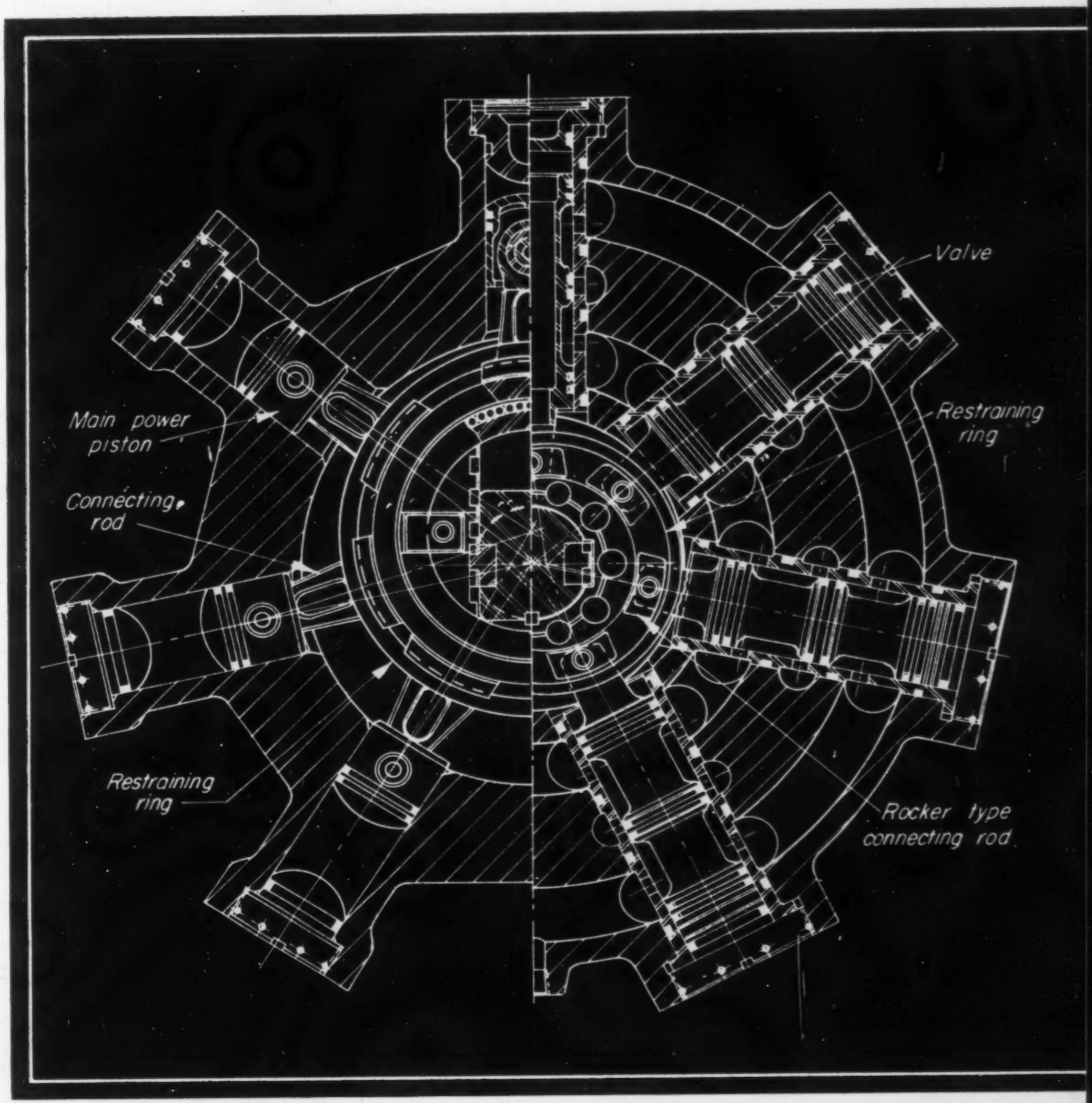
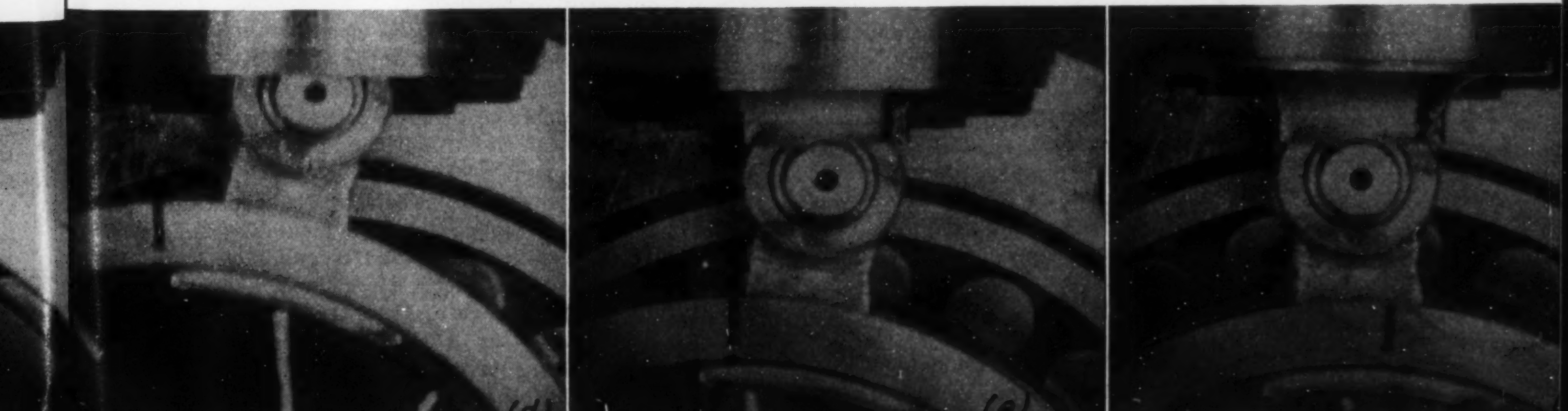

Valve
Restraining ring
Main power piston
Connecting rod
Restraining ring
Rocker type connecting rod

Fig. 3—Below—Six stills from motion picture of the modified design, showing lateral motion of connecting rod, oscillating motion of restraining ring, and nosing down of the bearing when reversal of motion occurs, as in views (c) and (d)



after only a short run, regardless of the materials used for the surfaces. These failures were particularly puzzling inasmuch as the similar type rods on the main power pistons, with much larger unit loading, performed perfectly satisfactorily.

It was felt at first that due to the similarity of design between the power piston connecting rod and that of the valve, the solution lay in the difference of forces acting in the two cases. In the power piston, the oil load is at all times much greater than either inertia or friction force so that it cancels them, giving a resultant force acting toward the center of the shaft. In the valve, oil forces are balanced and inertia and friction forces are the controlling forces.

Inertia forces are proportional to accelerations:

$$F_i = \frac{W r \omega^2}{2}(\cos\theta + p\cos 2\theta)$$

while friction force would be proportional to velocity:

$$F_f = K\,\omega r(-\sin\theta - \frac{p}{2}\sin 2\theta)$$

where r = eccentricity of eccentric, θ = angle of rotation, ω = angular velocity, W = weight of parts, and K = factor of proportionality.

It can be seen that the two forces are 90 degrees out of phase, one being a function of *cos θ* and the other of *sin θ*. The resultant will therefore be a complex curve depending on the magnitude of factor *K*. Unfortunately, there were not enough data to evaluate *K*. An assumption was made that all friction losses occurred in the valve and *K* was approximated on that basis. The *magnitude* of the resultant force was found to be such that the bearing load was quite low, but the *character* of the force was such that the load was carried by the eccentric during part of the time and by the restraining ring for the remainder of the time.

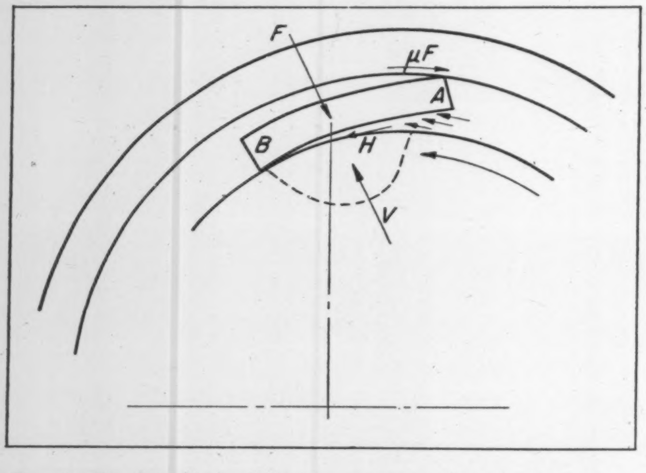


Fig. 4—Combination of forces acting on bearing when reversal of restraining ring motion occurs

The foregoing, of course, is true for both types of valve connecting rods, and therefore was not the whole answer to the problem. However, as was found later, it was the major cause.

Next, the kinematics of the two types of connecting rods were investigated. The rocker type, oscillating about its center, did not have any lateral motion, while the other one had a definite sliding. The calculated resultant velocities were found to be not excessive. It was the characteristic of motion in combination with forces that caused the trouble, as indicated by high-speed motion pictures (3000 frames a second) which were taken at this point of the analysis. Stills from these movies are shown in *Figs.* 1 and 3.

What the Pictures Show

In *Fig.* 1, which shows three points of one revolution of a rocker type connecting rod, the important feature is that the restraining ring does not rotate relative to the eccentric, though it does have a motion relative to the conncting rod. In *Fig.* 3, showing six points of one revolution of the alternate type of connecting rod, the rotation of the restraining ring is evident, along with large amplitude of oscillatory motion. It may also be noticed in *Figs.* 3*c* and *d* that the bearing noses down when reversal of motion takes place, this effect being more obvious when the film was run than it is in the stills. Shaft rotates counterclockwise. These observations indicate that the combination of forces shown in *Fig.* 4 acts on the bearing.

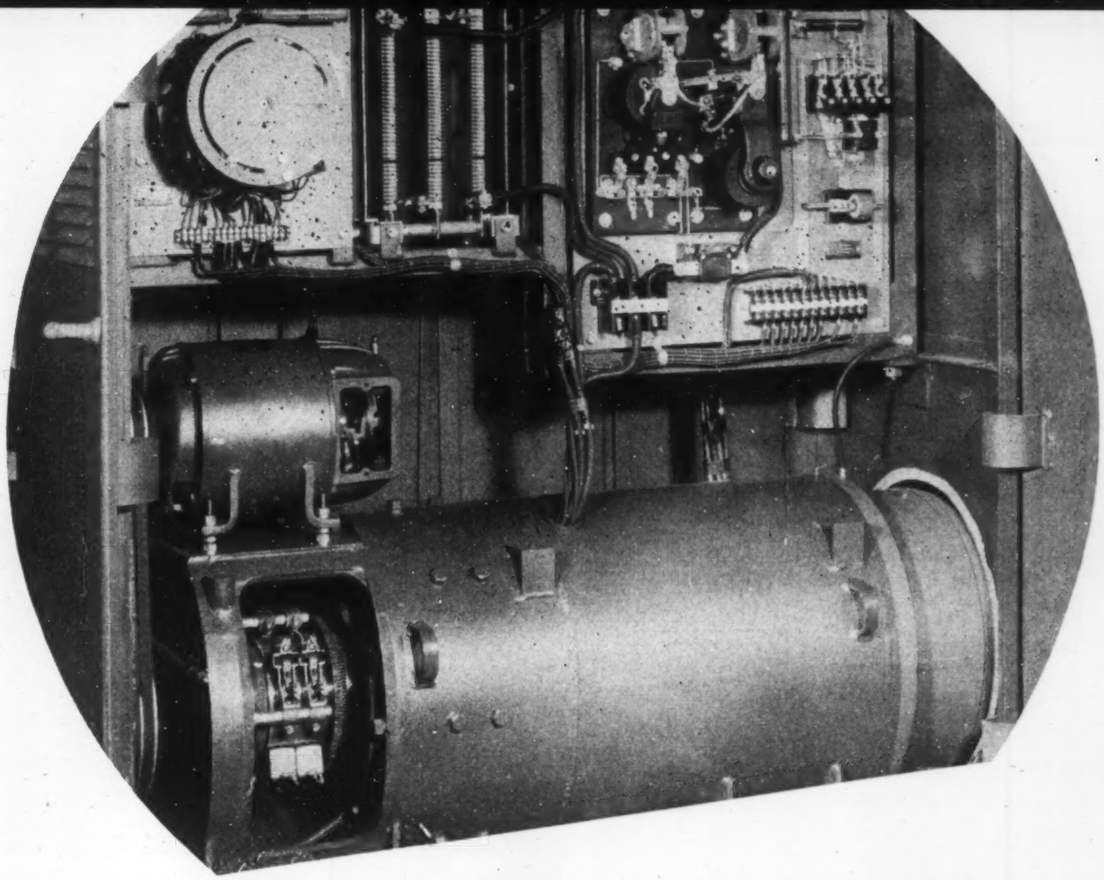
How Oil is Squeezed Out of Bearing

Hydrostatic pressure *V* is ample to balance force *F* but the oil friction force *H* forming a couple with force μF caused by the motion of restraining ring, causes leading edge *A* to drop, thus destroying the wedge forming pressure *V*. Force *F* then squeezes oil from under the bearing, making it run dry. On the basis of these findings, the following recommendation was made:

> The connecting rod surface that comes in contact with the restraining ring is to be crowned in such a way that force μF acts only on the trailing edge of the slipper for cases where direction of rotation is constant. In cases where direction of rotation changes, it is to be crowned in such a way that the ring bears only in the center of the slipper. This is to reduce the effect of the force μF on the slipper in its tendency to level off.

This recommendation was followed in correcting connecting rods on a 3-cylinder motor, and an endurance test was run off at 2000 psi oil pressure and 2400 rpm. After the test the bearings were examined and showed no wear.

In this case a purely analytical analysis could have been possible if all the data were available, but it would have been a very long and complicated work, while the study of the high-speed motion pictures of the moving parts taken at their true working condition, 1500 rpm, after a rather general study of forces and motions, gave a quick and satisfactory qualitative result.



Motor-Driven Rheostats

. . . for automatic or remote control of motor drives

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MOTOR-DRIVEN rheostats are increasingly being used for industrial and commercial control applications, especially where automatic operation is required. In typical control applications they are employed in preference to the manually operated rheostat either where the size of the rheostat unit prohibits manual operation or where remote and automatic sequential operations are necessary to the proper functioning of the machine or equipment. As an example, the motor-driven rheostat is used in automatic engine lathe controls for automatically regulating the speed of driving motor, *Fig*. 1.

Essentially, the motor-driven rheostat consists of two coupled sections, the rheostat and the motor-drive unit. The rheostat may be a single or multideck, circular or rectangular plate-type unit or it may be a face-plate ribbon or grid assembly. Many factors such as watt rating, number of steps, resistance, current taper, space allowance, ambient temperature, and others must be considered in the design of the rheostat. These factors are dependent on the particular application requirements. The motor-drive unit consists basically of a small fractional-horsepower motor, reduction gears, friction clutch, limit switches and frequently other control devices. A typical assembly for large rheostats is shown in *Fig*. 2.

Frequently motor-drive units are provided with slip clutches which serve two main purposes. By loosening the slip clutch the drive unit may be disconnected mechanically from the rheostat, permitting operation

Fig. 1—Top—Stepless adjustable-speed drive is a package unit containing motor-driven rheostat and other accessories

by manual control in the event the unit fails to function correctly. It also provides protection against mechanical damage to rheostat plate or rheostat contact arm caused by limit-switch failure. It should be mentioned that the slip clutch will not provide protection to the motor against overloads resulting from faulty operation of the limit switches. Overcurrent protection necessitates the use of overload relays or other devices which function when an overload occurs to disconnect the motor from the power supply, thereby preventing motor damage.

Operating speed of the rheostat is a function of the torque required to rotate it and the speed-torque relation of the motor-gear reduction. In most units, series-type split-field motors are used to simplify reversing and to obtain speed adjustment readily. An adjustable resistor or small control rheostat is provided for timing control, being connected in the motor armature circuit in a series-parallel arrangement.

Pushbutton Control

Operation of motor-drive units may be controlled by pilot control devices such as pushbuttons, limit switches, pressure switches and thermostats. As an example, the mtor driven rheostat shown in *Fig.* 3 is controlled by pushbutton stations PB_1 and PB_2 which are connected for two-wire control. Depressing PB_1 or PB_2 energizes the motor which, through a set of reduction gears, rotates the rheostat in either the clockwise or counter-clockwise direction of rotation inserting or shorting out sections of the rheostat. On reaching the end of travel, driveshaft cams open one of the limit switches, disconnecting the motor from the line.

During operation, if the pushbutton is released the motor quickly stops. The operating speed of the drive is controlled by the adjustable timing resistor. Increasing the resistance across the motor armature, that is, moving the center terminal band in the direction of the arrow increases the operating speed.

Motor-driven rheostats are used often to advantage in speed-control systems for automatically regulating the speed of direct-current motors driving numerous types of machines. A typical example of such a sys-

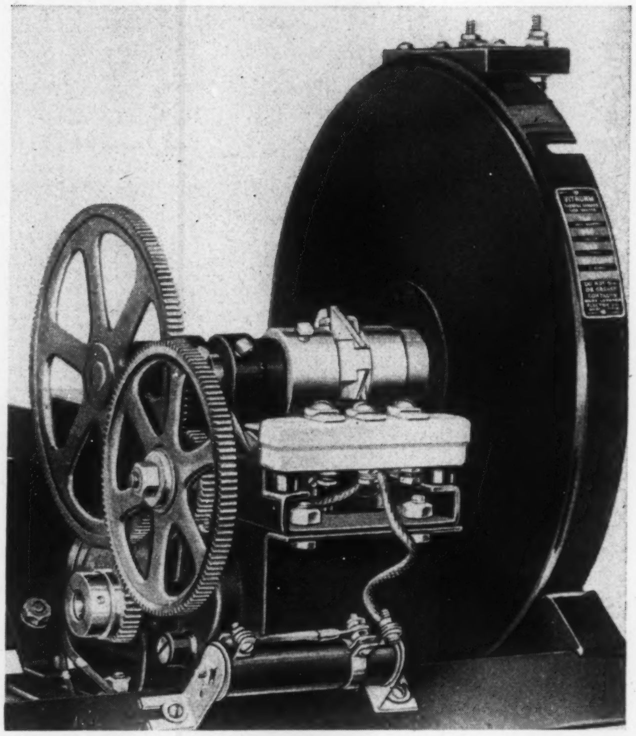


Fig. 2—Above—Rheostat unit and its drive. This type is adaptable to large assemblies

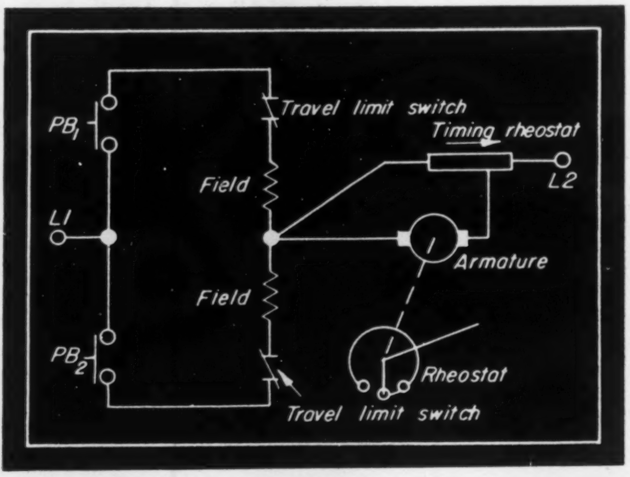

PB_1
Travel limit switch
Timing rheostat
L2
Field
L1
Armature
Field
PB_2
Rheostat
Travel limit switch

Fig. 3 — Above — Schematic diagram for pushbutton-controlled motor-driven rheostat

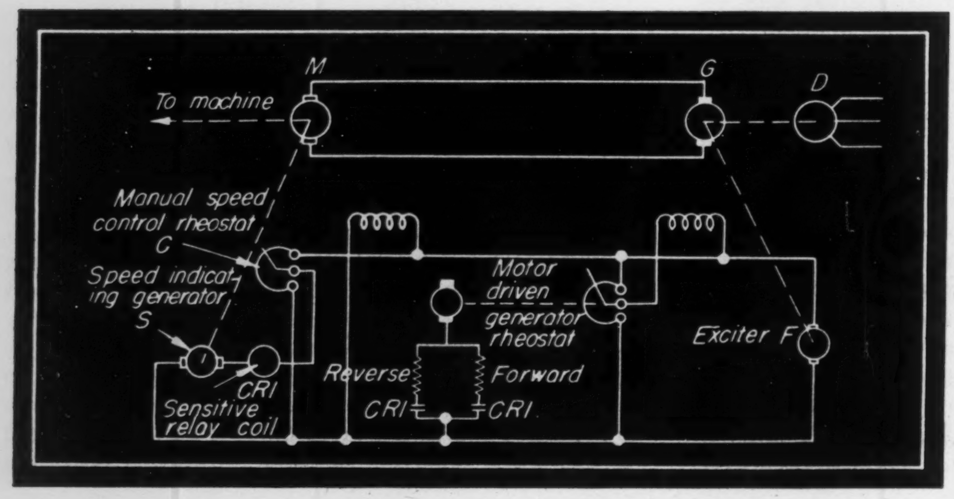

M
G
D
To machine
Manual speed control rheostat
C
Speed indicating generator
S
Motor driven generator rheostat
Exciter F
CR1
Sensitive relay coil
Reverse
Forward
CR1
CR1

Fig. 4—Left—Automatic speed control system for regulating direct-current motors

Fig. 5—Right—Elementary diagram for the series variable-voltage drive

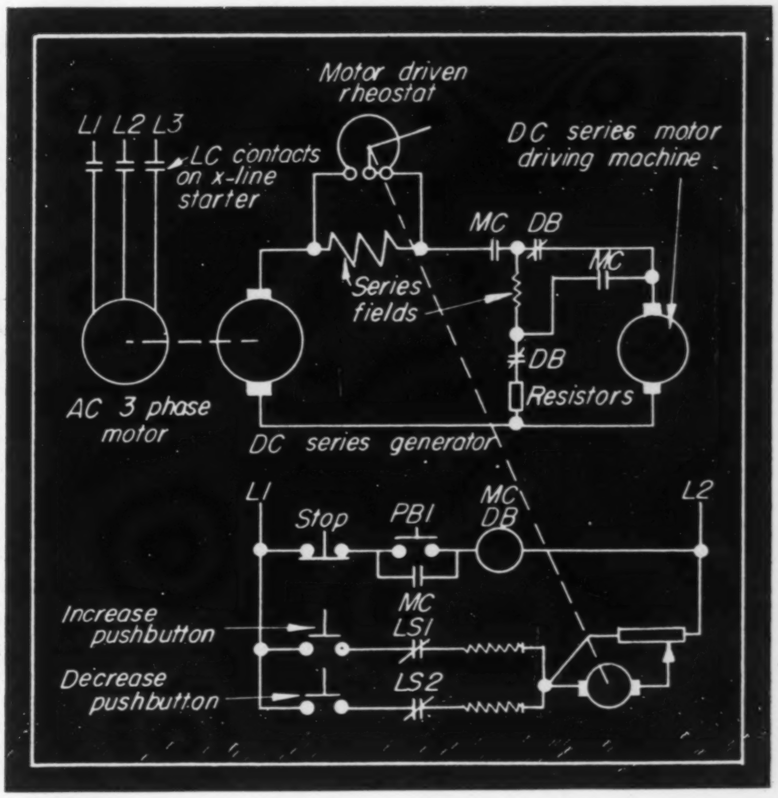
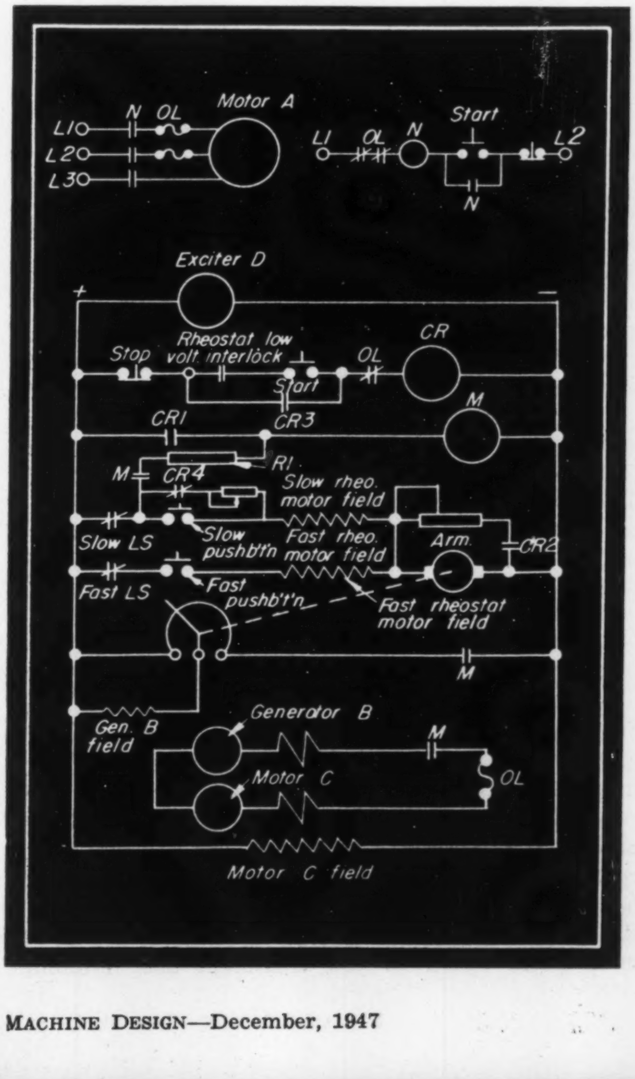

Motor driven rheostat
L1 L2 L3
LC contacts on x-line starter
DC series motor driving machine
MC
DB
MC
Series fields
DB
Resistors
AC 3 phase motor
DC series generator
L1
Stop
PB1
MC DB
L2
MC
Increase pushbutton
LS1
Decrease pushbutton
LS2

Fig. 6—Below—Adjustable-speed drive utilizing a motor-driven rheostat. Acceleration and deceleration are controlled automatically within wide limits


Motor A
N OL
L1
L2
L3
L1 OL N
Start
L2
N
Exciter D
+
—
Rheostat low volt. interlock
Stop
CR
OL
Start
CR1
CR3
M
M
CR4
R1
Slow rheo. motor field
Slow LS
Slow pushb't'n
Fast rheo. motor field
Arm.
CR2
Fast LS
Fast pushb't'n
Fast rheostat motor field
M
Gen. B field
Generator B
M
OL
Motor C
Motor C field

tem where immediate response is not required, and where a sensitivity of plus or minus one per cent normal motor speed is satisfactory, is shown in *Fig.* 4. The circuit is an adaptation of the Ward Leonard system of control and for simplification purposes, only the basic control components in the circuit are shown.

Referring to *Fig.* 4, *M* represents the motor to be controlled and *D* the driving motor or other source of power which rotates the shunt-wound generator *G*. The armatures of *M* and *G* are direct connected electrically while their fields are excited by the constant-voltage exciter *F* which is direct coupled mechanically to the rotating shaft of generator *G*. To provide a means of speed indicating, small generator *S* is used and it is coupled mechanically to motor *M*. Both the motor driven generator *G* field rheostat and the manually operated speed control rheostat *C* are potentiometer connected.

Voltage-sensitive relay CR_1 has single-pole double-throw contacts provided with a contact finger which operates in a floating position between two stationary contacts. The relay contact finger remains positioned between the two stationary contacts as long as the voltage in the speed indicating circuit remains within the prescribed limits.

System Is Automatic

After setting the dial of control rheostat *C* to the motor speed desired, the system is fully automatic. Any change in the speed of motor *M* due to load fluctuations is automatically reflected in the speed indicating circuit causing a potential change across the coil of sensitive relay CR_1. This relay then functions to close one of its contacts, completing the circuit to the motor-driven rheostat motor which rotates the generator field rheostat to increase or decrease the generator *G* field excitation, thus causing a corresponding change in the generator output voltage to restore proper motor speed. When motor *M* is operating at a speed, preset by the speed-control rheostat *C*, the sensitive relay remains in neutral position. Since CR_2 relay contacts are open, the position of the motor-generator field rheostat is unchanged.

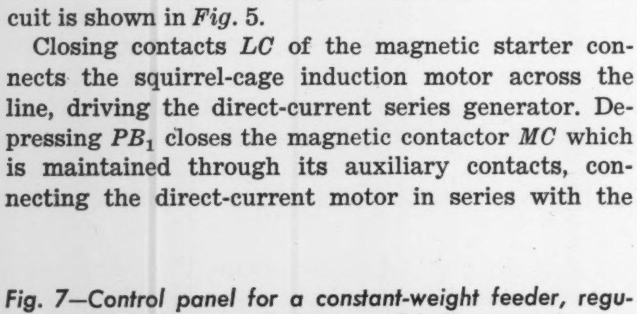
Series Variable-Voltage Drive

The motor speed-control system known as the "series variable-voltage drive", though primarily intended for use with fractional-horsepower motors for driving machine-tool head stocks or similar loads, is also applicable for larger horsepower drives where an extremely wide speed range is not required. This system is substantially different from the Ward Leonard system since no exciter is necessary. It provides a 10 to 1 speed range, a high starting torque of 3 to 4 times full load torque at 1/10 motor speed, and fairly good speed regulation. On fractional-horsepower series variable-voltage drives, a manually operated rheostat is generally used for regulating the speed, but on larger horsepower drives a built-in motor-driven rheostat may be used. The basic circuit is shown in *Fig.* 5.

Closing contacts *LC* of the magnetic starter connects the squirrel-cage induction motor across the line, driving the direct-current series generator. Depressing PB_1 closes the magnetic contactor *MC* which is maintained through its auxiliary contacts, connecting the direct-current motor in series with the series generator. Control of the motor speed is obtained by depressing the "increase" or "decrease" pushbutton station which operates the motor-driven rheostat. After the required motor speed is reached, the speed-control pushbutton may be released, stopping the motor-driven rheostat and maintaining the desired motor speed.

Dynamic braking is used on the series motor for quick stopping purposes. Depressing the stop button de-energizes the magnetic contactor *MC*, opening contacts *MC* and closing contacts *DB*. The *DB* contacts in closing, insert dynamic-braking resistors across the motor armature, bringing the motor to a rapid standstill.

Fig. 7—Control panel for a constant-weight feeder, regulating the rate of delivery of bulk material



Adjustable-Speed Drives

In adjustable-speed electric motor drives for machinery such as machine tools, textile machinery, equipment in paper mills, and steel mills, many special operating features must be included in the control to meet specific application requirements. Many of these drives, using motor-driven rheostats, require that the rheostats be designed with operating features unobtainable on standard units.

One such all-electric unit utilizing a specially designed motor-driven rheostat is known as the Reliance V*S Drive, *Fig.* 1. It is a completely packaged, adjustable-speed machinery drive which operates from alternating-current circuits to provide—electrically or electronically—an operating speed range of as much as twenty to one.

Stepless speeds are obtainable throughout the range, with rapid acceleration and deceleration rates which may be preset. Low speeds and jogging are available for threading and setting-up operations. Dynamic braking or regenerative braking can be supplied in the system which is basically the variable-voltage method of control.

This adjustable-speed drive contains an alternating-current drive motor, a direct-current generator, a separate rotating or electronic direct-current exciter and the necessary control devices, such as magnetic contactors, relays, resistors, etc. All equipment is compactly arranged within a steel cabinet which is supplied with air drawn by a fan through outside filters. The fan, mounted on a shaft extension of the driving motor, keeps cabinet interior under pressure to effectively exclude outside dirt and dust and to permit location of the unit beside the machinery it is to serve.

Controls Rate of Acceleration

In *Fig.* 6 is illustrated a typical circuit for this drive using a motor-driven rheostat for controlling automatically the rate of acceleration or deceleration within wide limits. Resistors and a control relay are arranged in the motor circuit of the rheostat so that automatic recycling to the slow-speed position is accomplished on stopping the main motor driving the machine. Adjustable limit switches are provided on the motor-driven rheostats, permitting setting of the main-motor speed to the maximum and minimum speed required. The rheostat is of the built-in type mounted within the drive housing as shown in *Fig.* 1.

Referring to *Fig.* 6, operation of the power drive may be briefly described as follows: On closing contact *N*, motor *A* drives generator *B*. The field of the main driving motor *C* and generator *B* are excited from exciter *D*. Depressing the start button energizes control relay *CR* which functions to close line contactor *M*. This action connects generator *B* electrically to main motor *C* which rotates at slow speed.

To increase the speed of motor *C* at a uniform rate of acceleration the fast pushbutton station is depressed. Limit switch *Fast LS* limits the travel of the rheostat and hence the maximum operating speed of motor *C*. To decelerate the motor, the slow pushbutton is depressed.

Rheostat Operates at High Speed

To bring the main motor to a rapid standstill a system of regenerative braking is employed. When the stop button is depressed, control relay *CR* drops out, opening contacts CR_1, CR_2 and CR_3 and closing CR_4 which short circuits the slow pushbutton station. This action operates the rheostat at high speed, reducing the generator voltage in a few seconds. When the generator voltage is less than the counter-electromotive force of the motor, current is passed through the armature of the generator, effecting dynamic braking. During this short time interval, line contactor *M* is maintained through resistor R_1, contact *M* and *Slow LS*. When the motor driven rheostat reaches the slow speed position *Slow LS* opens, de-energizing contactor *M* and disconnecting the main motor *C* from generator *B*.

Where more rapid stopping is required, dynamic braking (wherein the motor armature is disconnected and then short circuited by resistors) is used. For hoists, elevators and other machines which have a high inertia or where there is danger of overhauling loads, magnetic brakes are generally supplied in addition.

Electrical Vibration Equipment

In electrical vibration equipment which is widely applied on processing operations such as conveying, drying, screening and packing motor-driven rheostats are often used in the automatic controls. A typical example would be the constant-weight feeder known as the Waytrol the control panel for which is illustrated in *Fig.* 7. The basic function of the feeder is to deliver material such as chemicals, plastics, cement, metal ores and the like from a supply hopper and to regulate the quantity or rate of delivery of this material.

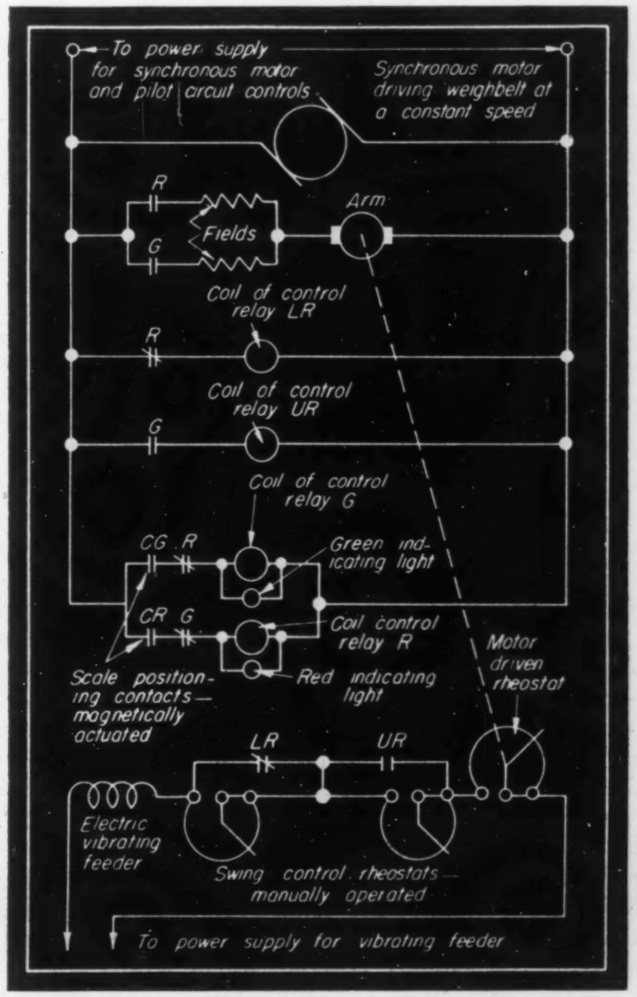
Essentially the feeder consists of a weighing belt complete with a vibrating feeder, scales and electrical control. The weighing belt, which is driven by a synchronous motor and which receives the material from a supply hopper, is counter-balanced at a fulcrum point by a calibrated scale. When this continuous gravimetric feeding system is out of balance, the electric controls function to increase or decrease the rate of vibration of the electric vibrating feeder thereby maintaining uniformly the amount of material delivered. The function and operation of the motor-driven rheostat in the electric controls for this constant weight feeder is illustrated schematically in *Fig.* 8.

If the load on the weighbelt is underweight the magnetically actuated contacts *CG* close, energizing the green light relay *G* and lighting the green light. This action causes the mercury-tube relay *UR* to close, short circuiting the *LH* swing-control rheostat and allowing full-voltage current to flow from the motor rheostat. This instantly increases the speed of the vibrator feeder, permitting more material to be delivered to the weighing belt. At the same time the motor driven rheostat, since contacts *G* are closed, operates to further increase the current flow to the vibrator feeder, thereby increasing the rate of material supplied to the weighbelt.

When exact balance is reached and the prescribed rate of flow of material is obtained, the mechanically actuated contacts *CG* open dropping out relays *G* and *UR* which function to stop the motor driven rheostat and reinsert the *LH* swingcontrol rheostat in the vibrator-feeder circuit.

On excessive weighbelt loads, the operation is reverse of the underweight condition, i. e., relay *LR*

Fig. 8—Simplified schematic diagram of controls for a constant-weight feeder


To power supply for synchronous motor and pilot circuit controls
Synchronous motor driving weighbelt at a constant speed
R
G
Fields
Arm
Coil of control relay LR
R
Coil of control relay UR
G
Coil of control relay G
CG R
Green indicating light
CR G
Coil control relay R
Red indicating light
Scale positioning contacts—magnetically actuated
Motor driven rheostat
LR
UR
Electric vibrating feeder
Swing control rheostats manually operated
To power supply for vibrating feeder

opens and the motor-driven rheostat increases the resistance in the vibrator-feeder circuit to decrease the current flow and in this manner reduces the amount of material supplied to the weighing belt.

Selection of Control

In selecting the motor-driven rheostat best suited for an application, the designer should be thoroughly familiar with the precise requirements; that is, exactly how the rheostat will be used and what its performance requirements will be. To avoid misapplication the rheostat manufacturer should be supplied the following information with respect to the rheostat requirements:

1. Electrical characteristics
2. Mounting and enclosure
3. Unusual operating conditions
4. Motor-drive voltage and frequency
5. Time periods of operation
6. Manual operation

ELECTRICAL CHARACTERISTICS: Engineering data concerning the electrical characteristics of the rheostat section of the motor drive assembly is necessary for proper application. In general, where the rheostat is applied for generator-voltage control, the excitation curve should be supplied. The excitation curve is most important where the rheostat is used in conjunction with a voltage regulator for automatic generator control.

For direct-current motor-speed control, a field-current versus motor-speed curve should be supplied. Through using these curves, the current or resistance taper of the rheostat may be more accurately determined. Excitation or current-speed curves are particularly necessary where special regulation is required. However, where this data is not available, alternate information should be supplied. One or more of the following electrical requirements of the rheostat should then be given:

a. Maximum current, minimum current and rheostat resistance
b. Maximum current, minimum current and line voltage
c. Minimum current, load resistance and line voltage
d. Load resistance, rheostat resistance and line voltage
e. Maximum current, rheostat resistance and line voltage
f. Minimum current, rheostat resistance and line voltage.

MOUNTING AND ENCLOSURE: Rheostat drives above 10 kw are generally floor mounted, while smaller self-contained units may be arranged for wall or back of switchboard mounting. For most high-current applications, the face-plate type of motor-driven rheostat is satisfactory. In certain instances a drip-proof or water-proof enclosure may be required as a protection against one or more of the operating conditions outlined in Requirement 3. It should be mentioned here that if the rheostat is totally or only partially enclosed its rating must be considerably reduced, which means that a much larger size of unit is required. In fact, such enclosures especially those of the water-proof type become so cumbersome that it is often uneconomical to use them. Since a rheostat may be controlled from a remote point, it need not be mounted near the machine it controls, and in this manner the use of special enclosures may be avoided by mounting in a more convenient location.

UNUSUAL OPERATING CONDITIONS: If the assembly is to be mounted where excessive dust, salt spray, explosive vapors, etc., are present, this fact should be brought to the attention of the manufacturer so that special protection may be provided. For instance, if used on a marine installation, the unit must be constructed to withstand the normal shock, vibration, tilt and atmospheric conditions encountered during normal shipboard operation. Special mounting brackets, enclosures, plating of parts, etc., frequently are required to meet these adverse operating conditions.

MOTOR DRIVE: For the majority of applications, a split-field series universal-type motor is used to drive the rheostat. The motors usually are designed for 110 or 220-volt alternating-current or direct-current operation. In alternating-current applications, where only high voltages, that is, 440, 550 or 600 volts are obtainable, a transformer is used to reduce the line voltage to 110 or 220 volts, thus permitting the use of a standard motor.

TIME PERIODS: Travel time, from the "all resistance in" position to the "all resistance out" position, is 30 seconds for most standard motor-driven rheostats. Longer or shorter travel times are available through the use of different reduction gears. Extremely high-speed operation is limited by the number of plates in the assembly or by the size of the face plate. In general, the smaller the rheostat the more readily high-speed operation may be obtained. Travel time may be arranged so that it is adjustable where required.

MANUAL OPERATION: Frequently, especially on the larger face-plate type of rheostats, manual operation is necessary in addition to motor-driven operation. To accomplish this a slip clutch is provided which may be loosened to disengage the motor, permitting rheostat control by means of a manual operating handle connected to the rheostat shaft.

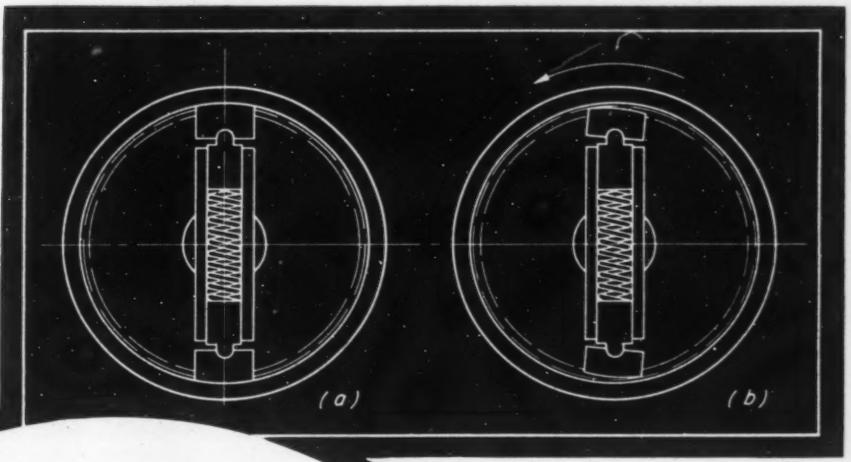
Consideration of the foregoing six factors is important with respect to correct selection and to efficient operation of rheostats.

Annual Index

IN THIS ISSUE is published the Annual Index of editorial contents, beginning on Page 195, as an added convenience to readers. In addition, as in previous years, the index will be available in a self cover upon request. Contents of the year's issues are divided into two groups: One is an alphabetical listing of authors accompanied by article titles and the other a cross-referenced index of subjects.

Fig. 1 — Right — Diagram showing the action of a fluid film clutch (a) with shoes engaged and (b) when slipping

Fig. 2 — Bottom of Page — Adjustable torque-limiting fluid film clutch partially disassembled to show elements

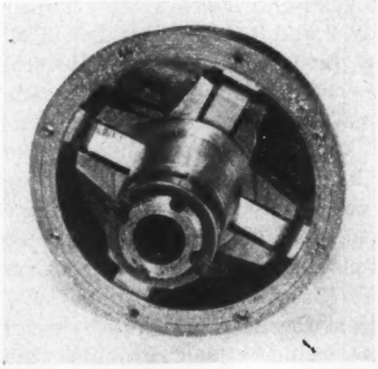


Fluid Film Clutch

New application of a well-known principle is basis of torque-controlled clutch of unique design

By Otto E. Wolff
*Research Dep't.
Polaroid Corporation
Cambridge, Mass.*

IT IS common knowledge that a fluid film separating two bearing surfaces can only be established and maintained by relative motion between the surfaces. When this motion ceases, the load expels the fluid and allows the surfaces to come in contact.



This principle is made use of in a new class of clutch devices with special characteristics which make possible simpler and more effective types of torque control in diversified fields. Some of its applications include clutches which disengage when the load becomes excessive and re-engage when the load is removed; transmissions which automatically select the gear ratio to suit the load and speed conditions; automatic lock-in clutches for fluid drives and torque converters to eliminate slip loss; automatic brakes for holding loads when they are brought to a stop; electric circuit breakers responding to excess load in any component of a machine; and simple couplings for guarding against damaging overloads on machine tools, motor-driven household appliances, automatic machinery, conveyors, marine propellers, mixers and other devices.

A torque-limiting clutch employing this principle may consist simply of a pair of self-aligning shoes mounted on a driving member in such a way that they bear against a continuous surface of a driven member in the presence of a lubricant, *Fig.* 1. In *Fig.* 1*a* the torque is transmitted by the solid friction between the shoes and the shell. When the torque becomes excessive, slippage occurs. Since the shoes are free to tilt, the slippage causes a wedge-shaped film of lubricant to be formed under the shoes, as shown in *Fig.* 1*b*, resulting in substantially complete disengagement of the driving from the driven element. As long as there is relative

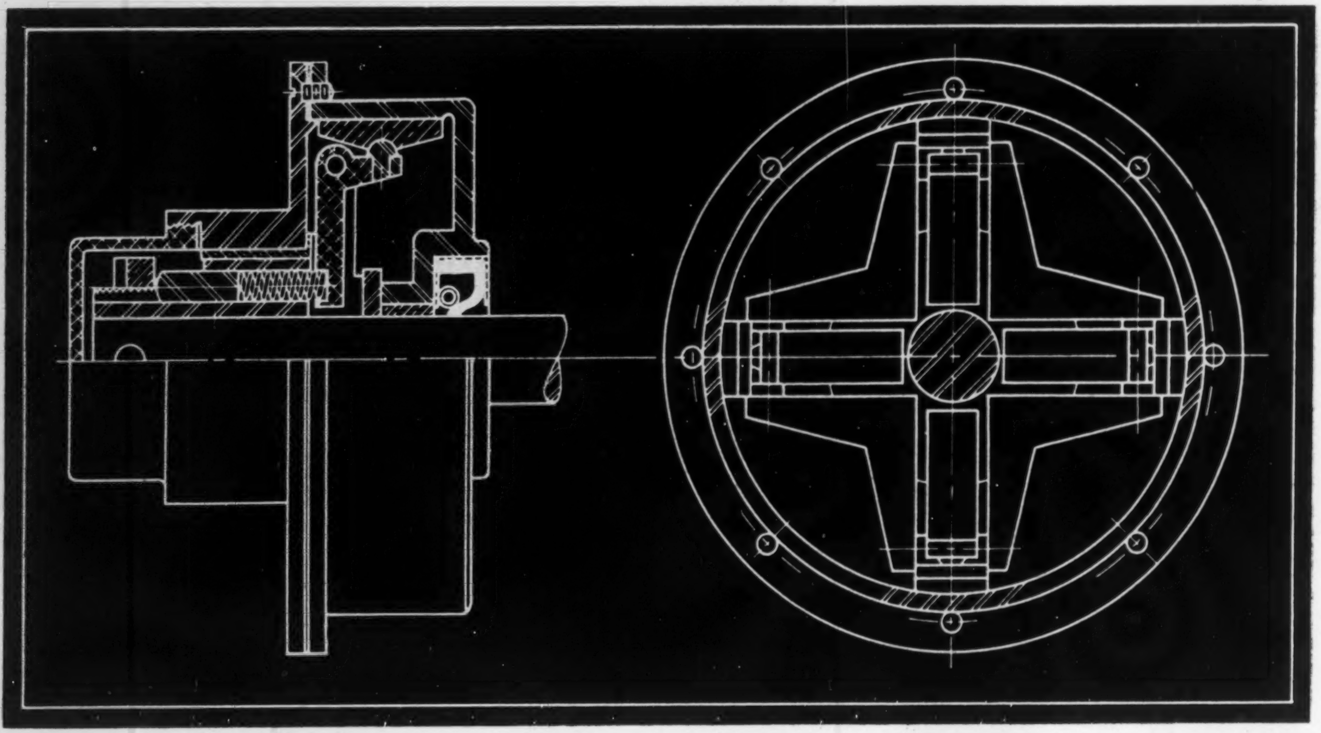


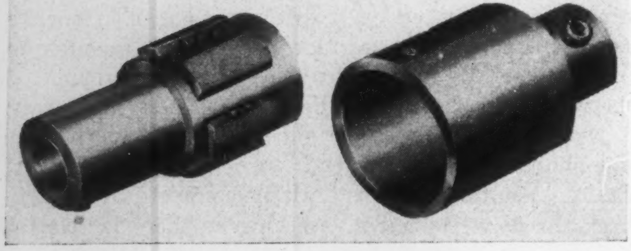
Fig. 3—Construction of the safety clutch shown in Fig. 2. Shoe pressure is adjusted by spring compression

motion between these elements, the clutch remains disengaged. If both elements are brought to rest or to the same speed, the film is broken and the clutch is re-engaged. The operation of such a clutch is independent of rotational direction, and either element may be driven.

Theoretical analysis of the formation of the wedge film has been given in the literature and will not be repeated here. When one surface slides over a conforming surface in the presence of a lubricant, the distribution of pressure in the lubricant depends on the bearing pressure, speed, viscosity of the lubricant, the geometry of the surfaces and the method of support. The ratio of the free-slipping torque to the torque which causes slipping varies with speed and viscosity, but is normally of the order of one per cent. The static frictional coefficients depend, of course, on the materials and the characteristics of the surfaces, but do not vary a significant amount for a given pair of materials.

Lubricants may be straight mineral oils. Oiliness additives are probably undesirable, but antioxidants, antifoam and extreme-pressure agents may be added. The lowest viscosity which will give adequate lubrication is preferred, in order to minimize the free-slipping torque. Water and aqueous solutions are used with rubber shoes. Water appears to be an adequate lubricant where speeds are high or the load is light. Metal shoes are designed for bearing loads up to 500 psi. For high-speed operation, greater spacing should be allowed between shoes to ensure lubrication. A clutch with a running surface 2 inches in diameter and 1 inch wide will handle from 10 to 35 lb-ft torque, depending on the speed of the application. In general, the shoes are pivoted centrally to operate in either direction. Where the unit is to operate in one direction only, the free-slipping torque may be reduced by pivoting the shoes closer to the trailing edge.

Fig. 4—Flexible coupling employing synthetic rubber core on which the shoes pivot



Characteristics Remain Unchanged

Clutches of this type appear to have a long service life. Some have been slipped continuously for over 100 hours and disengaged 50,000 times with no decrease in efficiency or change in the torque required to disengage.

The method used to load the shoes is determined by the application. *Figs.* 2 and 3 show a safety clutch in which the shoes are spring loaded through levers. The compression of the springs is adjustable by means of a nut. The couplings shown in *Fig.* 4 use a synthetic rubber core to apply radial pressure to the shoes from an axially loaded spring. The shoes bear directly on the rubber core and consequently no other pivoting means is required. The rubber core also compensates for shaft misalignment. The simple form of clutch shown in *Fig.* 5 is made by expanding a fluted rubber core against the bore of a hub by axial compression. Here the rubber itself provides the

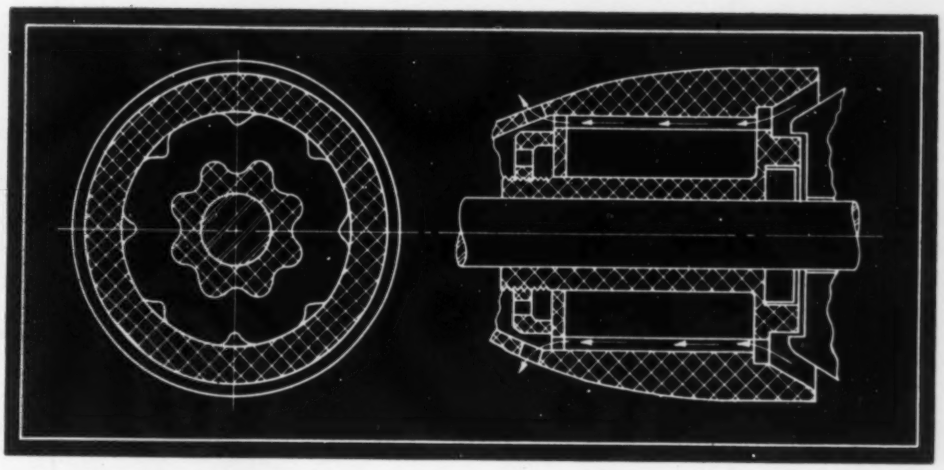


Fig. 5—Rubber in compression makes a simple safety clutch for a marine propeller hub. A film of water separates the clutch surfaces from the hub when slippage occurs

shoe surfaces and also reduces torsional vibration. Water may be used as the lubricant and this feature makes the type particularly suitable for use as a safety clutch in marine propellers. All of these clutches are re-engaged automatically when brought to rest.

The torque-limiting type of clutch is, of course, applicable to such machine tools as power screw drivers, nut runners and similar machines. In units for this service the free-slipping torque is sufficient to re-engage the clutch as soon as it is removed from the work. One advantage is the long service life, since any wear of the shoes is taken up by the loading means.

One interesting property of the oil wedge film is that it can be made to electrically insulate the driving from the driven element. Thus, with suitable construction, an electric circuit may be opened when a clutch slips.

Adaptable for High Starting Torque

Electric motors which are started across the line may develop starting torques considerably greater than their safe running torque. A safety overload clutch to be used with such a motor must therefore be designed to carry the starting torque without disengaging, but must disengage at a considerably lower torque when up to speed. This may be accomplished by using inertial or centrifugal unloading masses in conjunction with the loading springs to control the shoe pressures.

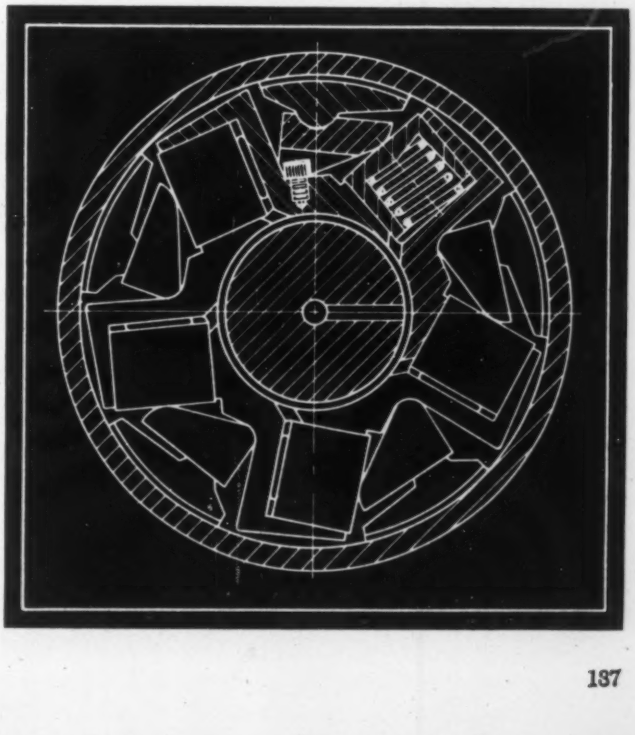
Other types of clutches in which the shoe loading is varied with speed find application in variable-speed transmissions. In the case of the hydraulic torque converter, the slip loss may be tolerated during low-speed accelerations, but it is quite desirable to minimize slip at normal operating speeds. In certain units, this is done by manually engaging a friction clutch in parallel with the converter after normal speed has been reached. By incorporating a centrifugally loaded slip clutch into the converter, the shift into direct drive may be made at the option of the operator by momentarily decelerating the engine. A further advantage lies in the fact that the shift back into converter drive is made automatically whenever the transmitted torque becomes excessive or the speed drops to too low a value.

In *Fig.* 6 is shown a section through a heavy duty, hydraulically loaded slip clutch for use in another type of automatic transmission. Hydraulic operation gives high torque capacity and also furnishes a convenient means for controlling the slipping torque.

It is often desirable to have a mechanism move freely, but lock when at rest as, for example, a feed adjustment on a machine tool. The fluid film principle may be used to advantage for this purpose. Here, the use of a high-viscosity lubricant makes accurate final adjustment possible by retarding engagement of the clutch for a second or two after the motion has stopped.

The fluid film torque control principle can be made to handle loads over a wide range of power and speed. Operation is silent and may be instantaneous. Its reliability appears to be excellent. It is adaptable to most situations where high, precise, static friction is to be combined with low sliding friction.

Fig. 6—Clutch design employing hydraulically loaded shoes achieves high torque capacity and flexible control



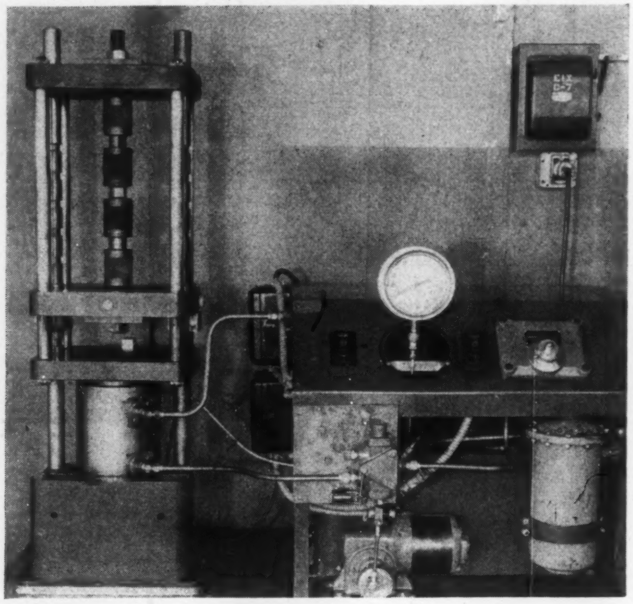


Fig. 1—Right—Hydraulically-operated machine and controls used to fatigue test three bolts simultaneously

By N. B. Green
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How Processing Affects Bolt Fatigue Strength

IN aircraft construction high-strength steel bolts are depended upon as primary fasteners in joining important components such as wings to fuselage, engines to mounts and landing gear assemblies. Ordinary AN bolts heat treated to 125,000-140,000 psi tensile strength were found to be inadequate in these special applications so the National Aircraft Standards (NAS) Committee evolved high-strength bolts which heat treat to 160,000-180,000 psi, are made to more exacting requirements than the AN bolt, and have a distinctive internal wrenching type head with sloping sides.

Static strength properties of the NAS bolt are well known. Like most bolts the head section is designed to be stronger than the threads under static tensile loading. However, this bolt often is used in critical applications subject to repeated on-and-off loading which necessitates a better understanding of its fatigue characteristics. Since there are several ways to form the socket-type head, and various methods of manufacturing threads, the best approach to the problem appeared to be investigation of the precise effect of head and thread manufacture on the tensile fatigue properties to define the "ideal" NAS bolt.

It is customary to eliminate the problem of fatigue in tension bolts by employing installation torques so high that the induced axial tensile stress approaches the yield point of the material. It follows that if the maximum service load on the bolt is less than the pre-stress in the bolt no further elongation occurs and, actually, there is no stress fluctuation within the bolt, so that its fatigue life becomes infinite. However, in aircraft construction excessive installation torques cannot be used for a number of reasons. In the first place abutments usually are an aluminum alloy which will not withstand the terrific clamping forces involved. In the second place flexure of bolted members during flight causes enough loosening to substantially dissipate the original torque. Moreover, yield-point installation torques would be impractical from a production standpoint, particularly in the larger sizes, because of the likelihood of deforming the socket as well as the difficulty involved in attempting to use an extremely long lever arm where a bolt is situated in an inaccessible or confined place. The conviction therefore persists that high-strength tension bolts in aircraft should be designed and manufactured with due consideration for fatigue resistance.

How Bolts Were Tested

A hydraulically operated test machine was designed and constructed large enough to test three bolts simultaneously. The bolts were arranged in a column and made up in suitable fixtures joined by heavy, threaded collars, *Figs.* 1 and 2. Outstanding features of this machine were uniformity of test conditions, smoothness of operation, ease of changing the bolts and small amount of maintenance work required.

Test bolts used in this investigation were procured from only one supplier and were manufactured according to applicable NAS drawings and Specification NAS 159. These bolts were obtained in two

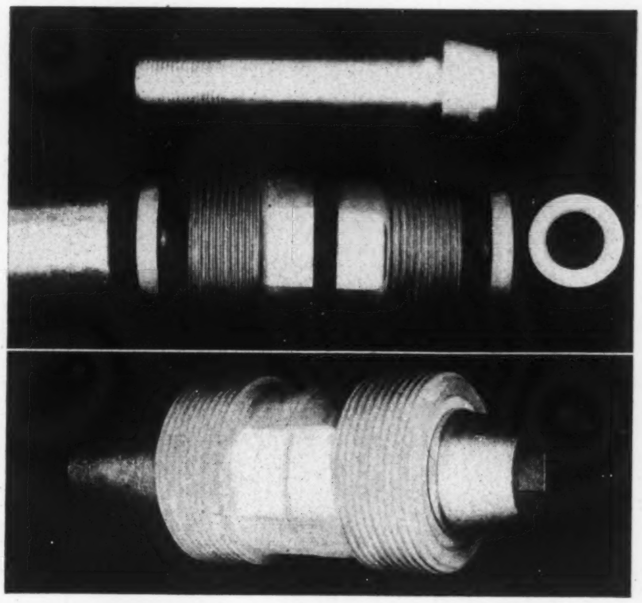
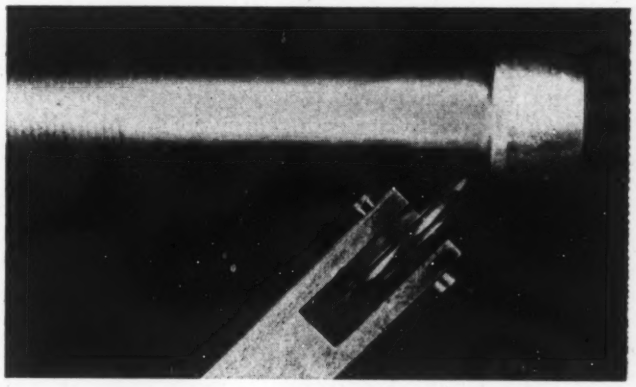


Fig. 2—Above—Fixture in which bolts were assembled for testing. Threaded members were joined by heavy collars shown in Fig. 1

Fig. 3—Below—Lathe setup used to roll head fillet



sizes, i.e., 9/16-inch diameter and ¾-inch diameter, and all were made from the same heat of 8740 steel. Various manufacturing procedures were specified for heads and threads as shown in TABLES I and II.

All test bolts were assembled in the fatigue machine with heat treated internal-wrenching type nuts and NAS 143 countersunk washers. The bolts were made up finger tight only—no installation torque being employed. The master nut on top of the machine was then tightened just enough to take the slack out of the column of test bolts and threaded fixtures. An arbitrary loading criterion of 35 per cent of the yield strength was selected on the basis of numerous experimental runs. Accordingly the NAS 149 (9/16-inch) bolts were loaded in tension from 0-12,075 pounds at the rate of 50 cycles per minute, and NAS 152 (¾-inch) bolts were loaded from 0-22,520 pounds at the same rate. Ten bolts of each head and thread classification in each size were cycled to failure, and the results averaged and tabulated as shown in TABLES I and II.

When this test program first was undertaken, the intention was both to simulate service conditions and compare various types of heads and threads. Therefore, in preliminary tests the bolts were assembled in the machine with the same initial wrenching torques used in production, namely, 75 foot-pounds for 9/16-inch bolts and 200 foot-pounds for ¾-inch bolts. This proved to be impractical, however, since it was found that induced axial stresses varied by as much as 5,000 pounds (in 9/16-inch bolts) from bolt to bolt owing to frictional effects and differences in fit between nut and bolt. Moreover a certain amount of loosening was observed in the torqued bolts during the first few thousand cycles. This extreme variation in the amount of pre-stress caused such a wide scatter of fatigue values that a comparison of bolt types was impossible. It therefore became necessary to reduce the installation torque to zero and confine the test program to a comparative basis.

The most important conclusion to be drawn from this investigation is that the ideal NAS fatigue bolt consists of one with both the head fillet and threads cold rolled after heat treatment. In general this type of bolt is from 4 to 10 times better than any other combination of head and thread manufacture. Differences in fatigue life between other types of heads and threads are minor and of little practical significance.

Rolling the head fillet was accomplished by making up special hardened rollers, *Fig.* 3, having a well-polished working edge with a radius slightly smaller than the fillets to be rolled. The sample bolt was mounted in a lathe, being held by its threaded end in a collet. The rolling tool was then set up on the carriage and fed into the head fillet at an angle of 45 degrees with the bolt axis, being held there with moderate force for approximately 30 seconds while the lathe turned at 190 rpm. Unfortunately no determination of the force with which the roller was held against the fillet was possible with this set-up. However, it was not excessive since the maximum deformation observed in a sectioned bolt was 0.002-inch and no laps or cracks were apparent. The astonishing increase in fatigue life that results from rolling the head fillet is easily understood, as this operation cold works the surface material and introduces residual compressive stresses in the same manner as shot-peening. The rolling operation is particularly effective when done on a decarburization-free surface which, in this case, is accomplished by finish grinding the shank, bearing surface and head fillet after heat treatment.

TABLE I

Fatigue Characteristics of NAS Bolt Heads

Method of Processing	— Average Cycles to Failure — NAS 149	NAS 152	Average
Cold upset head with machined socket and rolled fillet*	113,066+	87,559+	100,312+
Completely machined from bar stock	22,638	26,675	24,657
Cold upset head with machined socket	19,276	21,237	20,257
Head and socket hot forged complete	17,539	16,513	17,026

* In all cases the rolled head fillet outlasted threads rolled after heat treatment.

Superiority of threads rolled after heat treatment was to be expected in view of the considerable amount of cold working necessary to form the threads. Wide fluctuation in test results was noticed, however, which doubtless can be attributed to variations in the amount of decarburization. The thread portion of the bolt is swaged to the pitch diameter prior to heat treatment and is not ground afterwards. Thus decarburization is retained in the rolled threads. It would be interesting to determine the increase in fatigue properties occasioned by rolling the threads on a bolt which had been machined to the pitch diameter after heat treatment. Another factor which was not investigated was the possible effect of the 3-hour baking treatment for the relief of hydrogen embrittlement on the fatigue characteristics of rolled threads and head fillets. The test bolts used in this investigation were not so baked. No indication of hydrogen embrittlement was found and none was expected since the Rockwell hardness of the test bolts in all cases was less than C-40.

As has been indicated, other types of heads and threads, compared with one another, varied in fatigue resistance only to a slight extent. It is interesting to examine these comparisons further. For instance, it developed that bolt heads machined from bar stock showed better fatigue characteristics than either cold upset or hot forged heads. One reason for this might be that progressive failure is slower in shear than in tension since it was noted that bar stock bolts all failed by shearing through the head into the socket, whereas forged bolts usually failed in tension in a plane parallel to the bearing surface, *Fig.* 4.

TABLE II

Fatigue Characteristics of NAS Bolt Threads

Method of Processing	— Average Cycles to Failure —		
	NAS 149	NAS 152	Average
Threads rolled after heat treatment	113,066	87,559	100,312
Cut threads, machined after heat treatment	14,471	25,499	19,985
Cut threads, machined before heat treatment	12,373	14,234	13,304
Threads rolled before heat treatment	13,604	12,492	13,048
Threads ground before heat treatment	10,192	10,983	10,588
Cut threads, machined before heat treatment and then locally induction hardened after heat treatment (not plated)	.....	80,707	.....
Same as immediate foregoing, except cadmium plated and baked	.....	17,555	.....

Another interesting development was the behavior of different thread types. Contrary to all expectations ground threads had the shortest fatigue life while cut machined threads surpassed all others except those rolled after heat treatment. One of the most vital factors affecting the fatigue properties of threads is decarburization. Tests were made on cut threads and rolled threads both before and after heat treatment. Unfortunately, in the ground-thread category, only threads ground before heat treatment were tested. Nevertheless, a scrutiny of TABLE I shows that among the threads made before heat treatment, cut threads were the best by a slight margin, rolled threads next best and ground threads by far the worst. These results are, perhaps, best explained by a study of the various thread profiles in metallographic sections. The cut machined thread had a well rounded root with surprisingly good surface finish. The roughness generally associated with cut threads was confined entirely to the sloping sides where it had no effect on fatigue resistance. The ground thread profile of course showed excellent surface finish but was characterized by a flat bottom with fairly sharp corners which would naturally induce greater stress concentration. It was noted further that cut threads machined after heat treatment performed surprisingly well especially in the $\frac{3}{4}$-inch bolts. This of course could be explained by the absence of decarburization, but it might also be that the machining operation dragged and slightly cold worked the surface metal, thus enhancing even more its fatigue resistance.

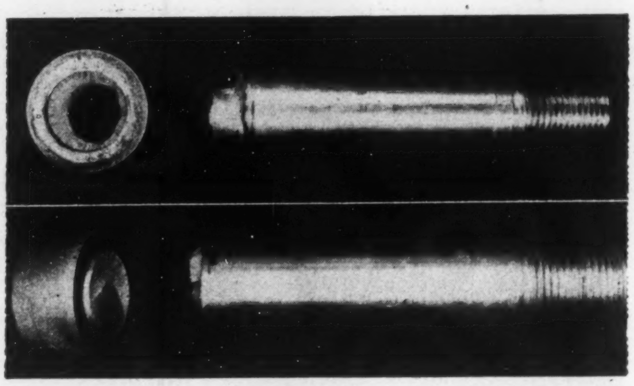


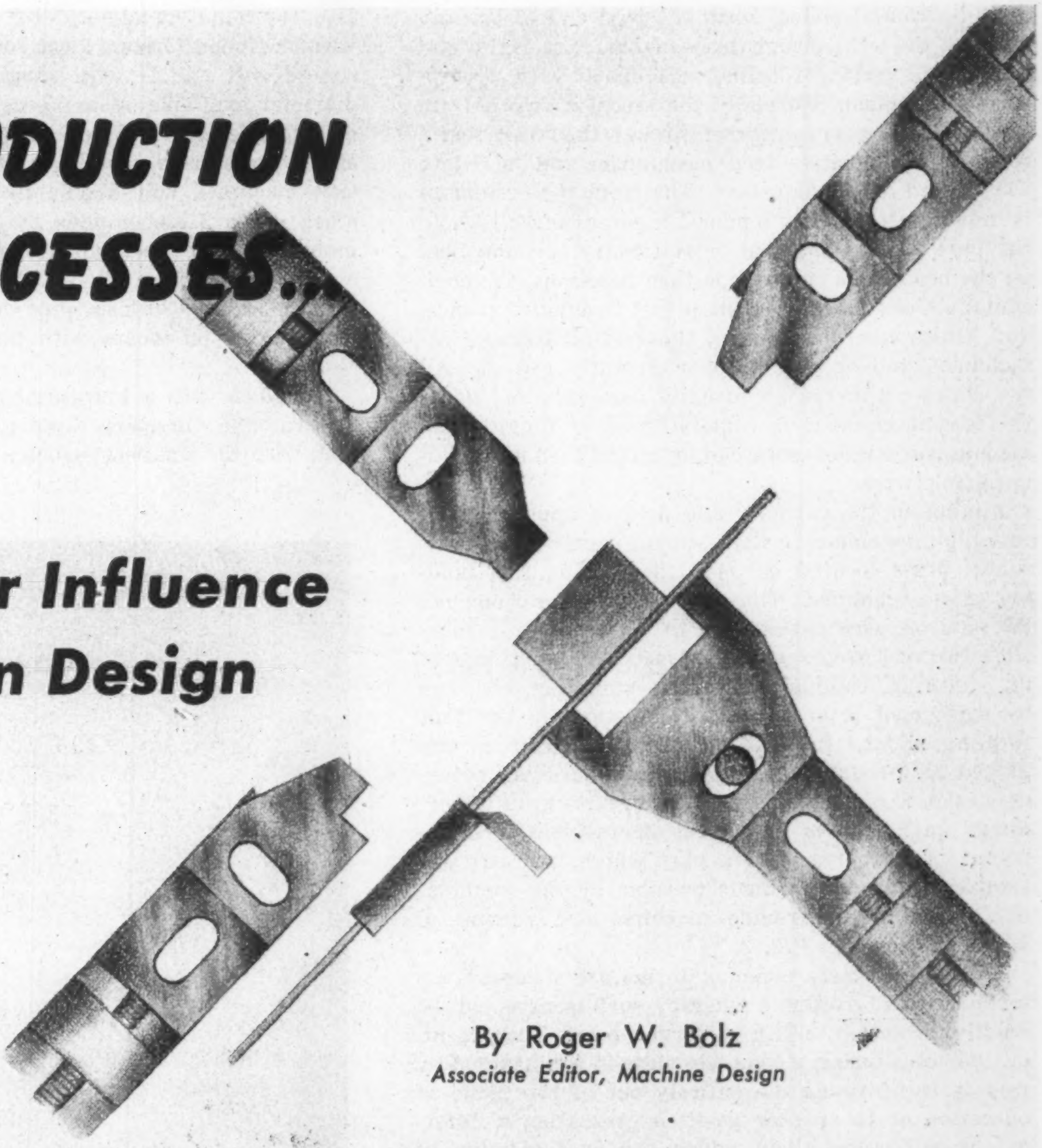
Fig. 4—Top—Heads machined from bar stock failed by shearing through head into socket. Bottom—Forged bolts failed in tension in plane parallel to bearing surface

Local induction hardening as a means of increasing fatigue strength has little application in aircraft bolts since it is necessary to cadmium plate such parts. It has been found that with present plating practices, the hydrogen embrittlement of 0.40 carbon alloy steel, heat treated to Rockwell C-45 or above, is unavoidable, and as was demonstrated in this investigation, baking relieves only a small portion of this embrittlement. The bolts used in this special test were induction hardened to a surface hardness of Rockwell C-58 and then some of them were cadmium plated and baked 4 hours at 500 F. In spite of the thorough baking treatment the plated specimens developed only one-fifth the fatigue life of the unplated specimens. However, the improvement in fatigue resistance obtainable by induction hardening is substantial and might be used to advantage in the automotive industry, for example, in applications where plating is not required. A careful record was made of the Rockwell hardness of each test bolt and it was found that, in general, the fatigue life was unaffected by variations in hardness within the required range of C 36-40.

This investigation is incomplete in many respects but it contributes a certain amount of original data and points the way for future work. It shows, moreover, that a high-strength tension bolt with excellent fatigue characteristics can be produced easily and cheaply, since rolling the head fillet is a comparatively simple operation and one readily adapted to automatic machines. Although few companies have undertaken to roll threads after heat treatment, the feasibility of the process has been well established by at least one manufacturer.

PRODUCTION PROCESSES...

Their Influence On Design



By Roger W. Bolz

Associate Editor, Machine Design

Part XXX–Wire and Ribbon Forming

IN the continual search for the most economical and satisfactory method by which a specific part or parts can be manufactured, the capabilities of the wire forming machine and its many variations necessarily must not be overlooked. Wire and ribbon-metal forming machines rank high among our oldest mass-production machines, having appeared on the manufacturing scene about the same time as the first cold headers, along about the middle of the nineteenth century. Known widely today by the general term "four-slide machines," those now available are the result of an evolutionary process which began with single-slide machines. Although many varieties of wire forming equipment are empolyed, *Fig.* 1, the four-slide machine embodies those features most universally adaptable and most useful in producing wire and ribbon parts, *Fig.* 2.

Although a great volume of the wire and ribbon-metal products other than coil springs undoubtedly fall outside the machine field, a tremendous variety of machine parts fall within the scope of this versatile production method. Electrical components of all sorts, bushings, sleeves, rings, forms, clips, hooks, arms, spokes, and ribbon and wire spring forms of great variety are characteristic of the type of parts well adapted to production by means of the wire forming machine, *Fig.* 3. Intricate parts, requiring many separate operations when produced on conventional presses, can be produced rapidly and with high accuracy, automatically and without handling. Setup flexibility of four-slide machines and ingenuity in tooling offers an almost unlimited field of design variations in forms and combinations of forms, *Fig.* 4.

Essentially, the basic four-slide machine consists of a stock straightening arrangement, a feed mechanism for wire or ribbon-metal, a cutoff unit, four horizontal slides—with the feed end of the machine at the left—designated as front, rear, right, and left, and a vertical forming attachment with a stripping mechanism. Normally the stock is drawn from a horizontally positioned reel through the straightener rolls by the positive feed mechanism and is fed to the desired length as preset. The front tool, commonly referred to as the "binder," then advances to hold the part against the tool or stationary forming post on the head. The cutoff slide then functions, the horizontal slides following in the preset forming sequence, and lastly, where necessary, the vertical forming attachment and/or the stripper operate, *Fig.* 5. All the slides employed are usually cam actuated while the feed mechanism is usually crank or toggle actuated in conjunction with cam-operated feed and holding grip clamps.

Adding to the capacity and field of application of four-slide machines is the optional feature of a horizontal press located between the feeding and holding grip mechanism. Thus preforming operations can be done on wire parts prior to entry into the four-slide forming area. On ribbon-metal, piercing, blanking, forming, coining, embossing, stamping, etc., can be performed prior to final completion by the four forming slides. In addition, the slides can be employed for producing flats, cutting or forming notches, necks, or slots, pointing ends, upsetting, or assembling. In *Fig.* 6 is shown the operational sequence layout of a representative part which indicates the complexity of design made possible by the combination press and four-slide machine, one version of which is shown in *Fig.* 2.

Where extremely complex forms are involved, attachments are available whereby such designs can be readily produced. With a form-raising attachment, parts necessitating a complete close-in are handled by raising the forming die entirely out of the plane of operation or to another position presenting a different cross section about which the final forming of the wire can be done. Even three die levels have been used in certain cases.

A wide variety of plain forming machines, four-slide machines, attachments and adaptations are available for handling almost any design requirement in wire or ribbon forms. Plain formers and simple four-sliders will handle wire ranging from the smallest diameter available up to ½-inch diameter, maximum, in soft-steel wire. Wire can be of almost any available cross section, metal analysis or finish. Combination machines will handle in addition ribbon-metal stock up to 3 inches wide by 3/32-inch thick. Maximum length of stock which can be fed for producing a part ranges from about 2 inches with the smallest machine for 0.030-inch wire or 3/16-inch ribbon, to as much as 30 inches with the larger machines for ½-inch wire.

Machines with a horizontal press attachment have an available die space ranging from ¾-inch by 1¼-inch with the smallest machine to around 5 inches by

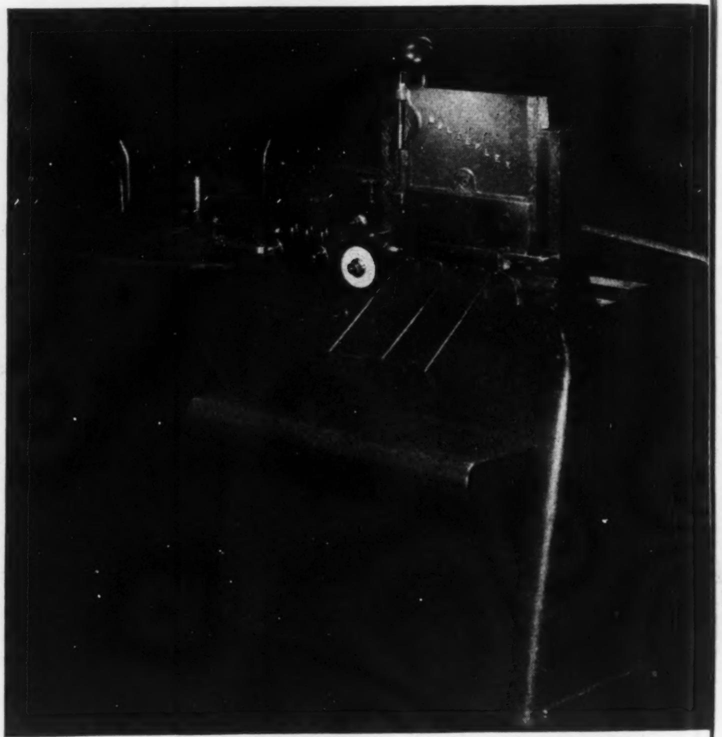


Fig. 1—Above — Multeplex wire forming machine affords high production on simple single-plane parts

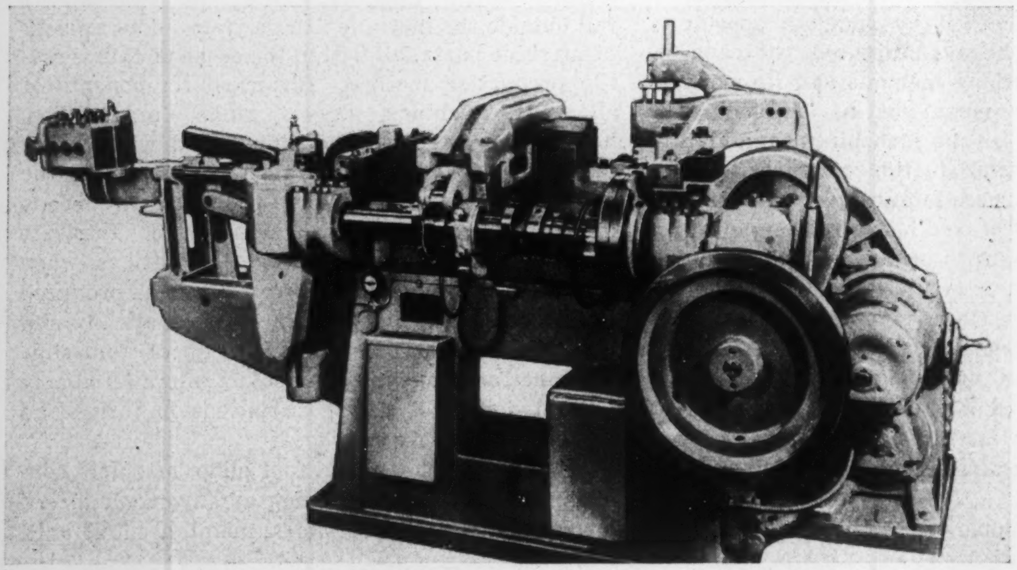


Fig. 2—Left—U.S. Multi-Slide No. 33 machine for ribbon or wire provides a feed length of 15½ inches and will handle ribbon up to 2½ inches wide by 3/32-inch thick or wire stock up to ¼-inch in diameter

13 inches with one of the largest. Certain machines allow as many as three separate die heads to be mounted on the bed of the unit for handling the more complicated parts. Where design requires heavy duty coining or embossing operations, the larger machines have available lever or toggle press units capable of exerting up to 100 tons pressure.

With the simplest plain forming machines, *Fig.* 1, production speeds range from 40 to 180 pieces per minute while with the four-slide machines production speeds may range all the way from about 500 pieces per minute with extremely small parts to about 30 pieces per minute on large parts. Ordinarily, machine production speeds are based on a maximum wire or ribbon feed speed of 100 feet per minute and consequently length of feed required for parts may have a direct effect upon output.

In addition to attachments previously mentioned, four-slide machines often are provided with unusual or entirely special equipment for extremely high-quantity mass production or unusual design requirements, *Fig.* 7. Hopper or magazine feeds can be used to handle parts previously cut to length for performing preliminary operations

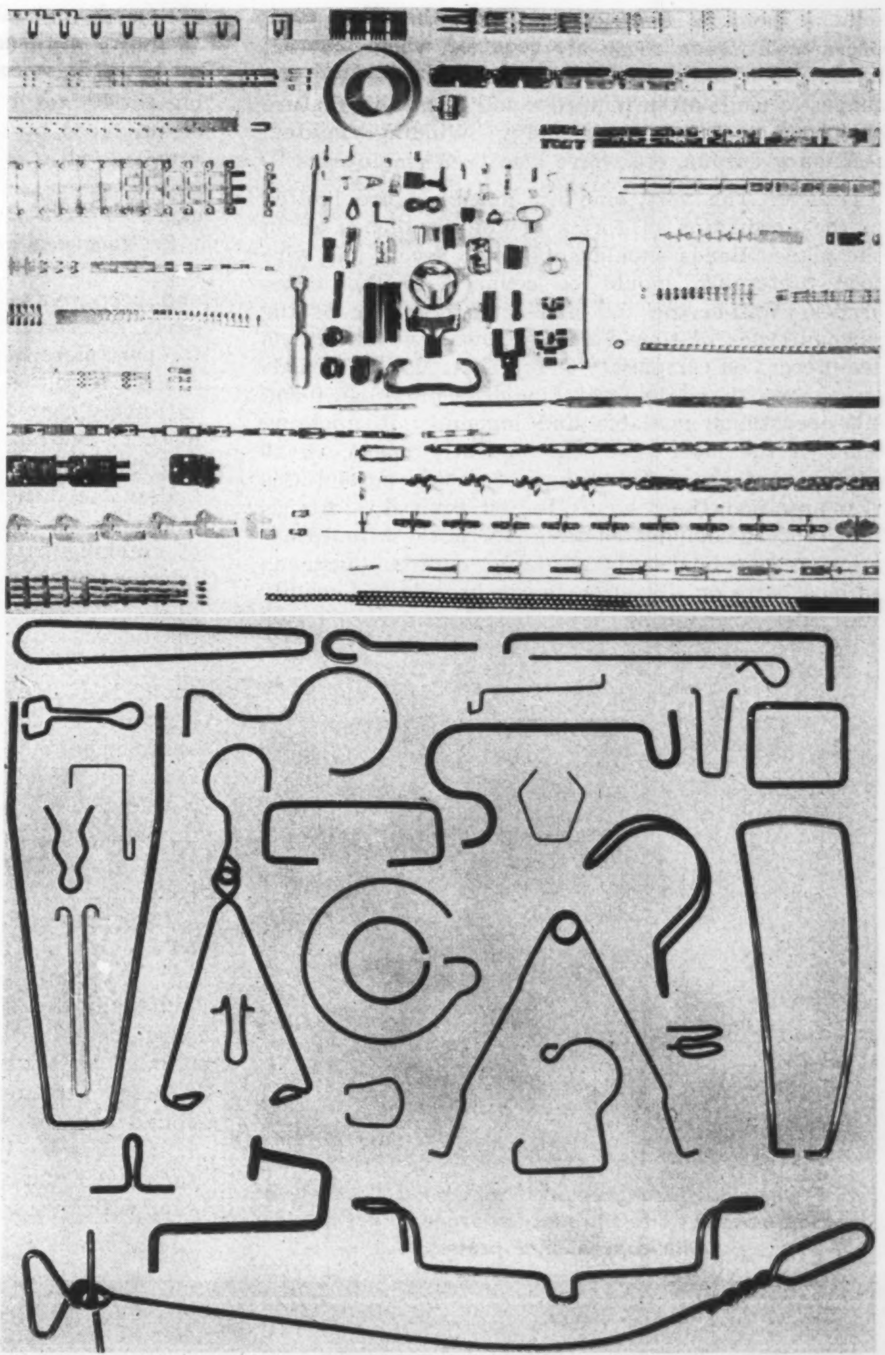
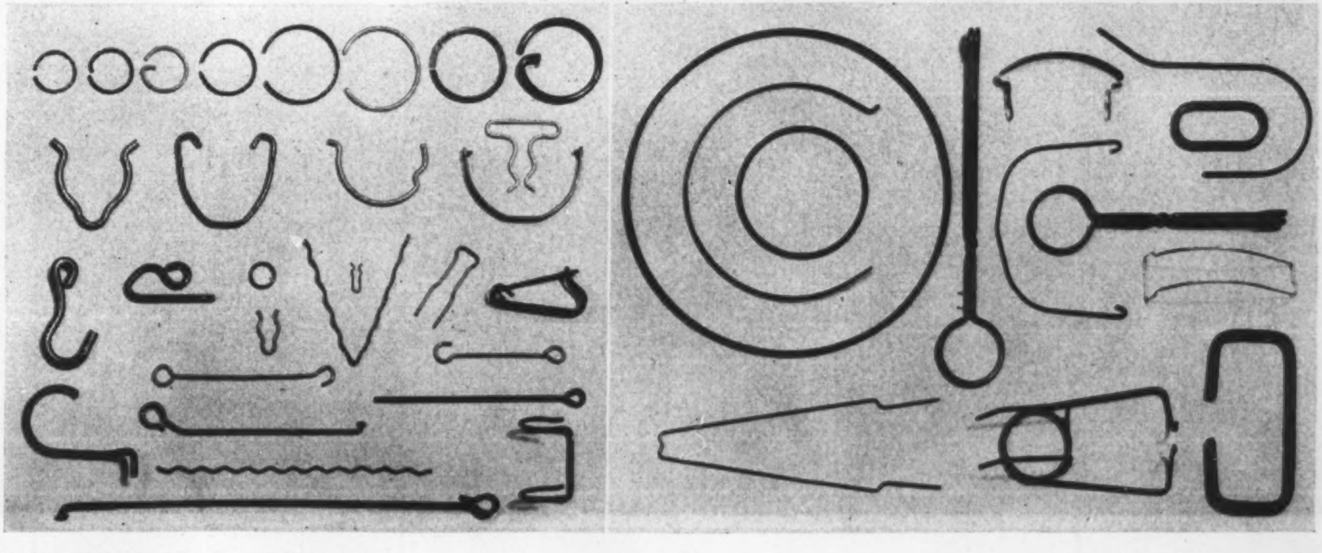


Fig. 3—Right—Machine parts formed from ribbon or wire stock on various types of four-slide machines



such as pointing ends, milling ends, threading, etc. Occasionally such feeds are required where several forms are to be assembled in the machine. Various shapes of rings often require welding and this feature has been included occasionally. Winding, milling, secondary cutoffs, etc., have also been employed.

DESIGN: The very simplest machines are limited to the production of forms having the bends all in one plane. Bends should not be too severe and wire used preferably should be confined to the softer grades. Within the size and capacity range of the various types of four-slide machines few limitations are present on complexity of form. Actual limitations are found only in the total number of press and forming operations available and ingenuity in applying them in the most desirable sequence. Inasmuch as outlining of the actual range of design possibilities is impractical, the designer is best advised to discuss the proposed complicated designs with the wire former prior to consolidation of all design details. Inasmuch as most wire or ribbon parts can be obtained readily and most economically from spring and wire forms producers who normally have available a wide variety of four-slide machines, consultation with these suppliers cannot be overemphasized in respect to obtaining satisfactory, low-cost parts. Too, most parts can be produced by using the adjustable cams regularly supplied with four-slide machines. Because of this feature, even smaller runs than would normally be expected often are economical.

Photo, courtesy Reliable Spring & Wire Forms Co.

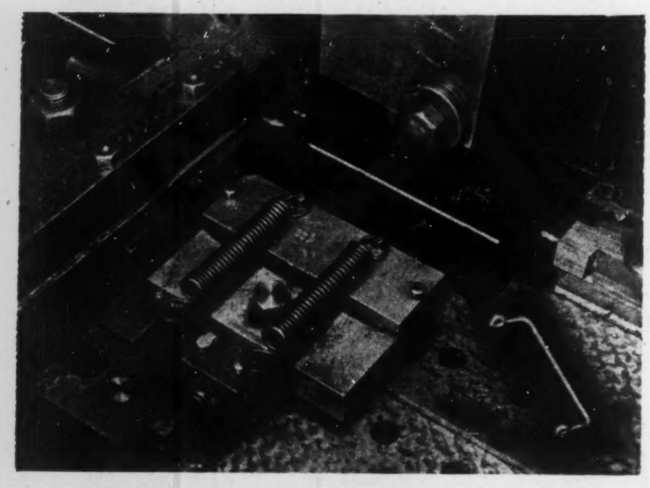
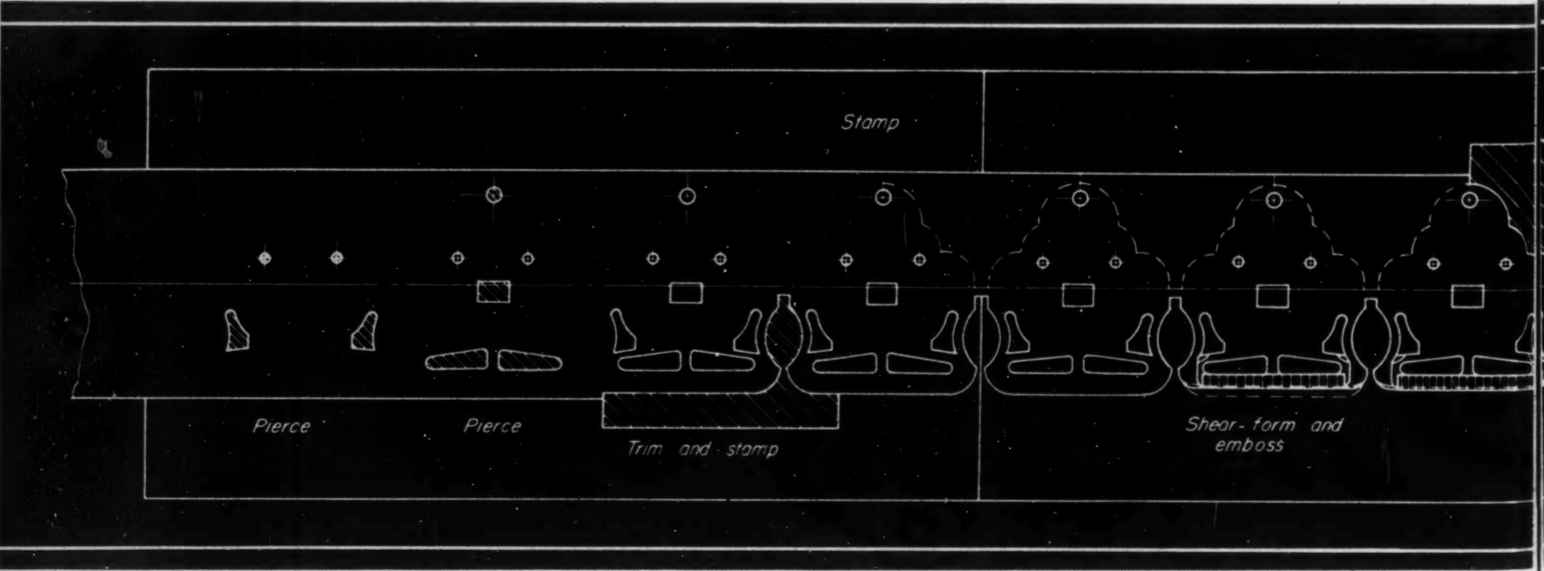


Fig. 4—Ingenious tooling coupled with setup flexibility of four-slide machines offers production economy not possible with conventional presses

Section area of wire or ribbon specified should be kept to a minimum to simplify the forming operation and keep costs down. In the case of spring action parts, excessive thickness may only operate to render the part more likely to fail. Wherever possible forms should be as simple as design permits. Although extremely complex parts are within the scope of this method, the less the complexity the lower the cost and the greater the production speed.

Radii of bends should never be less than metal thickness or wire diameter to avoid any possibility of cracking because of serious localized stresses introduced by sharp bends, especially with spring-action parts. Where metal to be used is in any other than the dead soft annealed condition, bends closer than two times wire diameter or metal thickness should be avoided. If feasible, larger radii should be employed; a radius of four times thickness or diameter just approaches the point of being the optimum. Likewise, sudden changes in cross section and improperly placed holes or slots should be avoided not only to minimize stress concentration but also to obviate tool trouble and to minimize warpage due to heat treatment.

It is impractical to produce a tightly closed ring of wire or tube from ribbon-metal with ordinary tooling. To obtain such parts a special setting operation is usually necessary to obviate the effects of metal springback and in cases of average work the standard vertical forming slide can be used. By using the setting operation on such parts practically perfectly round parts with tight joints can be had. However, if metal is too light in gage, results may be unsatisfactory. From general experience it has been found that with wire rings, for instance, in order for setting



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to be effective the wire diameter should not be less than one-tenth the diameter of ring to be formed. Bushings produced by this method may be plain or pierced, lettered, oil grooved, indented, dovetail jointed, etc.

Where upsets are desired, these should be designed for the smallest allowable upset of metal which will satisfy the design in view. Normally, only simple symmetrical upsets should be considered, complicated or special upsets cannot be handled.

In designing wire or ribbon-metal parts, the designer can utilize the standard beam theory in calculating deflection and stresses, $S = 6\ PL/bh^2$ where P = applied load, L = moment arm, b = width, h = thickness, and S the bending stress in the extreme fiber can be found in most available tables of physical properties. However, stress concentrations and cold working of the metal resulting from the forming operations complicates these problems so much that the designer should plan to confirm calculation results by experimentation with samples. This procedure is imperative where critical components with spring action are under consideration. Samples of parts are readily obtained from the producers of wire forms who usually maintain a sample department where even the most complicated form can be duplicated by hand. Except in the case of simple designs, tooling should never be begun until samples have been thoroughly tested and proved.

MATERIALS: As mentioned previously any type wire or ribbon-metal of any condition can be readily handled. However, the manufacture of many forms is rendered more difficult if hard wire or ribbon-metal is used. In fact, the hardness of the material has much to do with the layout and design of dies. For minimum die cost, soft or annealed wire should be used wherever requirements allow, especially where upsets, light extruding, embossing, or severe form-

Fig. 5—Right—Simplified layout showing tooling of four-slide machine for forming a simple wire part

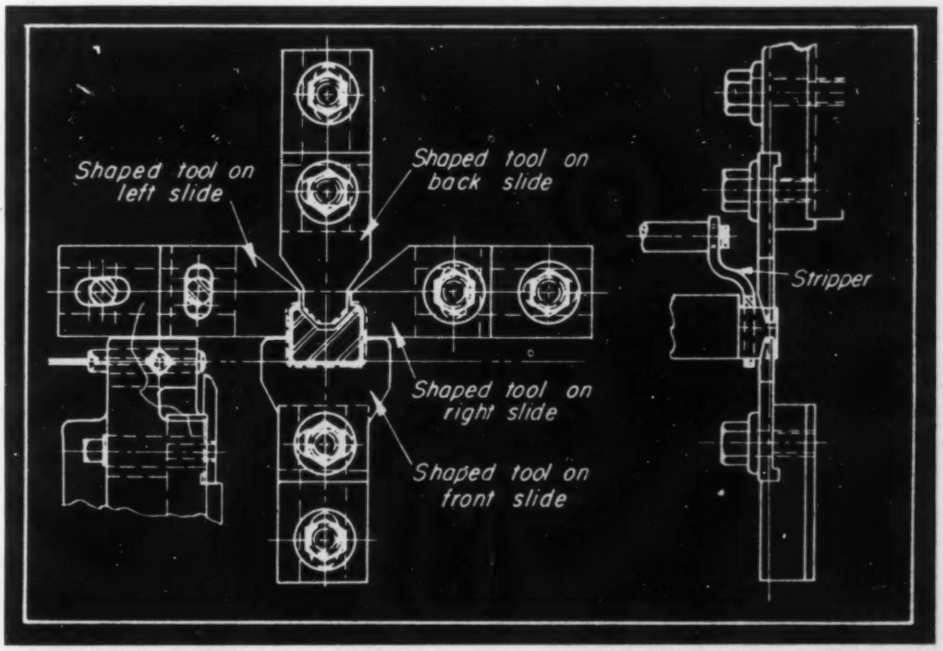
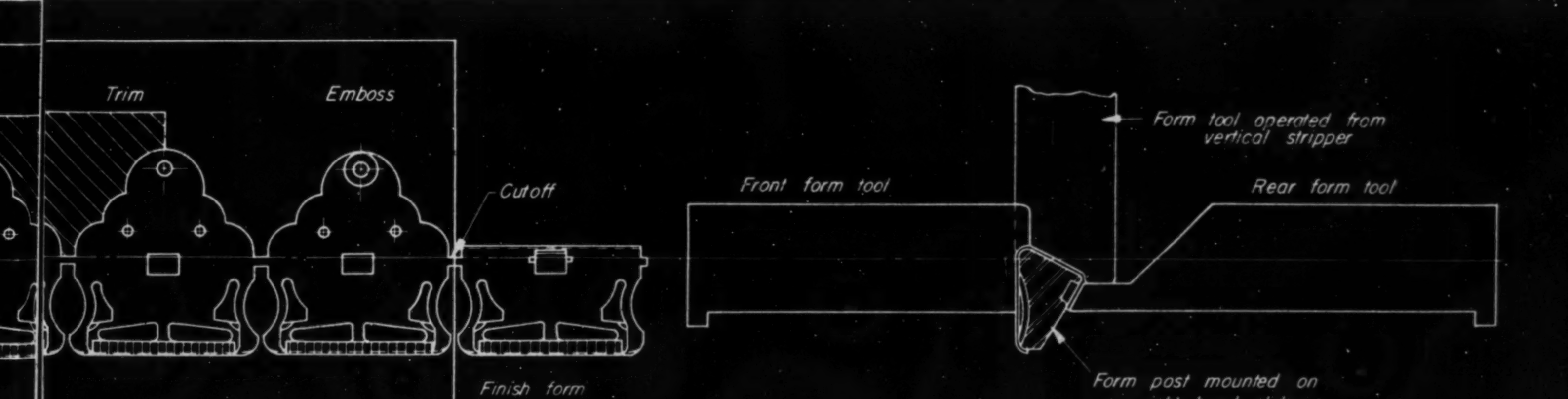

Shaped tool on left slide
Shaped tool on back slide
Stripper
Shaped tool on right slide
Shaped tool on front slide

Fig. 6—Below — Operational sequence layout of a ribbon part showing complexity of design possible with the combination press and four-slide forming machine


Trim
Emboss
Cutoff
Finish form
Front form tool
Form tool operated from vertical stripper
Rear form tool
Form post mounted on right hand slide

ing operations are contemplated. Capacity of most machines is based on soft steel wire and where harder varieties are used capacity ratings must be reduced.

Wire or ribbon-metal can be precoated with any commercial coating. These coatings normally run 0.0002 to 0.0005-inch and where heavier ones are desired costs are somewhat greater.

Where no spring action is necessary, parts can be produced from the following materials in order of increasing costs; Soft to ½ hard basic steel (1010 to 1020 Carbon), low-carbon bessemer steel, soft to ½ hard stainless, or nonferrous alloys in the soft to ½ hard condition, and aluminum. For spring action, the selection might be: Hard-drawn carbon steel (0.41 to 0.65 carbon), hard-drawn, high-carbon steel (0.65 to 0.95 carbon), annealed carbon steel (0.41 to 0.65 carbon), annealed high-carbon steel (0.65 to 0.90 carbon), pretempered steel (usually 0.55 to 0.70 carbon), music wire (0.70 to 0.95 carbon), 18-8 stainless in spring temper, and nonferrous alloys in spring temper.

TOLERANCES: Most wire forming machines produce parts with an accuracy closely akin to that found with stamping. Machines can be set to feed lengths of stock within a few thousandths of being uniform. Formed rings and bushings, thus, often can be held to within an inside diameter tolerance of plus or minus 0.0005-inch where the diameter-to-gage is within the limits covered under the preceding data on design and a setting operation is contemplated. Where the extra expense incurred with holding such accuracies is not justifiable wider tolerances should be employed, plus or minus 0.005-inch being an economical and readily obtainable accuracy.

Photo, courtesy Reliable Spring & Wire Forms Co.

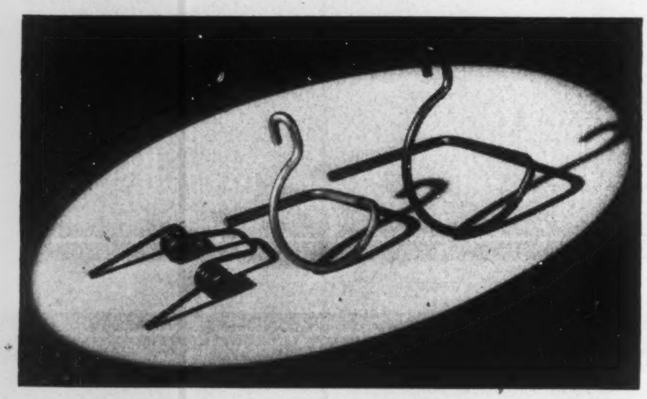


Fig. 7—Rifle grenade safety pins and special coil-spring wire form produced on a four-slide machine with special production attachments

Developed length can be held within plus or minus 0.005-inch in practically all instances with regular production practice. Therefore, practical tolerances on rings or parts containing rings would range from plus or minus 0.005-inch to around plus or minus 3/64-inch depending upon the ratio of radius to wire diameter or gage. Where coil spring sections are included on spring-action parts, *Fig.* 7, length tolerances would range from plus or minus 1/32-inch to 3/32-inch depending upon size.

Production parts which necessitate forming about a pin or form die naturally will have tolerances applied to those dimensions held by the form die. Certain dimensions on parts will therefore have the standard wire or ribbon-metal tolerances to consider in the overall tolerances on certain portions. Ordinarily, on average parts not too complicated in design, an acceptable tolerance on formed dimensions would be plus or minus 0.005-inch. Angular tolerances can be held to within a range of plus or minus ½ degree to plus or minus 10 degrees depending upon: (1) Ratio of radius to wire thickness at the bend, (2) ratio of length of material in the bend to material section area, and (3) quality of material.

Parts designed for ribbon manufacture ordinarily can be specified to carry overall length and width tolerances of plus or minus 0.005-inch. However, where holes or formed edges are included, tolerances on dimensions of these portions relative to the ribbon edges should not be required closer than plus or minus 0.010-inch to obviate the necessity of special dies for blanking out the entire shape.

Commercial Stock Tolerances Should Be Acceptable

Commercial wire and ribbon-metal tolerances should be acceptable on all parts to eliminate the need for special-size materials. Considering spring-action parts, commercial strip and wire tolerances also may enter the picture in still another way. Spring stiffness varies as the third power of the metal thickness so that within standard manufacturing tolerances there may be a variation in stiffness of three times the percentage variation in thickness or diameter. Similarly, safe spring load varies with the square of the stiffness, decreasing somewhat with the thinnest gages. Thus, for example, with 0.025-inch strip having a commercial tolerance of plus or minus 0.001-inch the stiffness will vary plus or minus 12 per cent and safe load will vary plus or minus 8 per cent. In the majority of cases these commercial variations are allowable but where greater accuracy is desirable it often may be obtained by special selection of material of special processing which incur extra cost.

Where sections are light and forming not severe, pretempered material can be readily used providing maximum control of production tolerances within normal physical material variations. Otherwise, annealed materials must be employed and the parts subsequently heat treated to obtain the desired properties. Because of the final heat treatment a certain amount of distortion is unavoidable and reasonable permissible tolerances with respect to dimensions must be allowed to avoid high costs due to rejects. In certain cases, if extreme accuracy of form is imperative, fixture heat treatment may be employed, but, of course, at somewhat increased costs.

Collaboration of the following organizations in the preparation of this article is acknowledged with much appreciation:

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(*Fig.* 1) .... Muskegon Heights, Mich.
A. H. Nilson Machine Co. .... Bridgeport, Conn.
Reliable Spring & Wire Forms Co. ......
(*Figs.* 3, 4, and 7) .... Cleveland, Ohio
Steel & Wire Machinery Co. .... Cleveland, Ohio
U. S. Tool Co., Inc. (*Figs.* 2, 3 and 6) ...... Ampere, N. J.

Putting Vibration to Work

By C. A. M. Thornton
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VIBRATION is usually considered to be a necessary evil associated with all moving machinery, which all concerned should endeavor to reduce to a minimum. However, vibration appropriately applied and suitably insulated from points where it is not required can be a very good servant and a most convenient "drive". Although the applications of vibrating drives have been considerably extended in recent years, the literature on the subject still appears to be scanty, and it is the purpose of this article to give an outline of the subject.

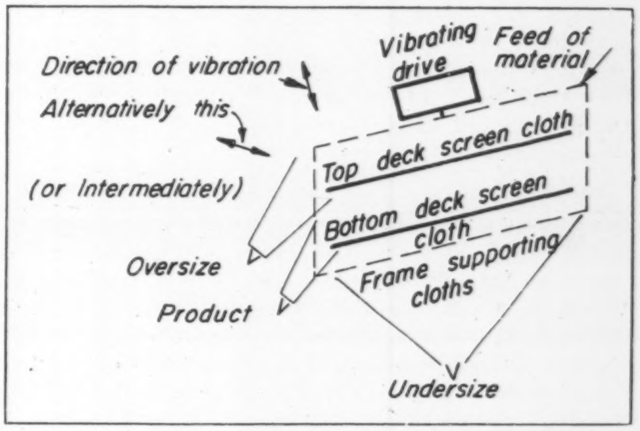


Fig. 1—Application of vibrating drive to screening with two decks, showing alternative vibration directions

SCREENING is probably the oldest application of the vibrating drive and still the most popular, *Fig.* 1. Screens are used for grading chemicals, fuels, stones, and—in conjunction with liquid sprays—for washing fine soluble material from larger lumps or particles. Vibrating screens may be totally enclosed and can be fitted with air blast or suction to assist in the grading or classifying. They may have an almost unlimited number of decks in applications where separation is required into numerous fractions. In this case, however, only one deck can work at maximum efficiency at one time. The vibration may be applied at right angles to the screening surface, or at some other angle if some "conveying" effect is also required.

CONVEYING: For purposes of conveying, the vibrating drive is applied at an angle to the conveying surface which is given an acceleration greater than that due to gravity, *Fig.* 2. The particles of material are, therefore, thrown forward into the air and land on the deck again at a point farther along. Material may be made in this way to flow up a considerable grade, but at less speed than on the level.

The shape of the characteristic curve connecting incline and speed of conveying is given in *Fig.* 3. The three divisions of the curve correspond to:

1. Hopping and sliding backward
2. Hopping without sliding
3. Hopping and sliding forward

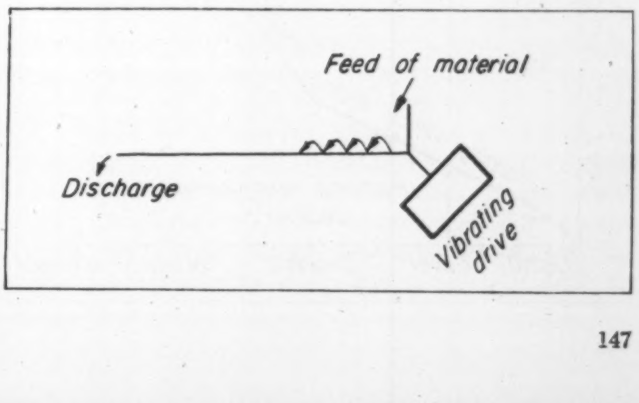
RECENT APPLICATIONS of vibration as a means of feeding parts into machines for processing have aroused new interest in this type of "drive". The accompanying article, which is based on a paper presented at a branch meeting of the Institution of Mechanical Engineers, outlines the subject with particular emphasis on the production and control of vibration by mechanical or electrical means

The remarkable feature of this method of conveying is the extremely slow rate of deck wear obtained, however abrasive the material may be. The author can testify to this after eight years' experience with a number of conveyors carrying abrasive material. The reason must be that although the deck would form a "nether millstone" there is nothing to act as an "upper millstone". However full the conveyor may be, all the material hops together.

It is for abrasive, hot materials, or for materials otherwise difficult for ordinary conveyors, that vibrating conveyors are chiefly used. Conveyors built with jackets carrying hot or cold fluids or gases form satisfactory dryers or coolers for various purposes.

Vibrating conveyors can give such a steady feed that they are often used for measuring purposes or, with suitable adaptation, for "constant weight" feeding, provided the characteristics of the material fed

Fig. 2—Application of vibrating drive to a feed mechanism or conveyor. Acceleration must exceed gravity



remain appreciably constant. The best conveying is obtained when the conveying surface has acquired a high polish.

Packing: Considerable savings can be made in container costs and shipping space by the use of vibrating drives for packing flake, powder, or granulated material. In the most extreme case that has come to the author's notice, a 40 per cent reduction in volume was achieved. Consolidation of sand in molding is another example of this service. The best amplitude and frequency of vibration depend on the shapes and sizes of the particles of material and experience is the only reliable guide.

Bin Vibration: This can be a most useful application, but care is necessary because, if the material is permitted to pack tight in a hopper, the object aimed at may be defeated. Experience is useful in this application as a guide for amplitude, frequency, point of application, and for deciding whether the vibration should be continuous or intermittent. It is essential for such a vibrator to be switched off when the flow of material is stopped.

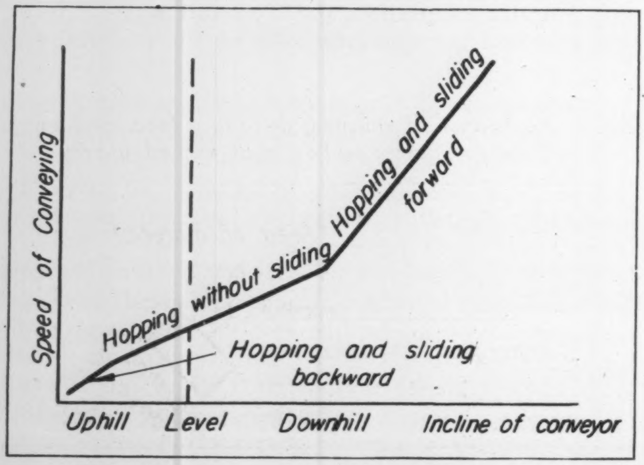
Amplitudes and Frequencies: The range of vibration frequency commonly employed in vibrating drives may be said to be from about 15 to 120 vibrations per second. The latest work on fatigue indicates that the maximum permissible stress is independent of the frequency of application. Although this may be nearly true under strictly controlled conditions, it is difficult in practice to prevent vibrating objects acquiring locally larger amplitudes at higher frequencies. Be this as it may, the fact remains that manufacturers of vibrating drives permit larger vibrations at lower frequencies, and vice versa. A good practical rule is that the product of the amplitude in inches and the number of vibrations per second should not greatly exceed a certain constant. Its value will vary with different designs.

Springs: Springs are required for two purposes:

1. As "main springs" of the vibration
2. As cushioning springs to isolate vibration from the supporting structure.

Main springs are generally either of flat rectangular section or of helical type. Cushioning springs are more often helical.

Fig. 3—Typical characteristic of vibrating feed



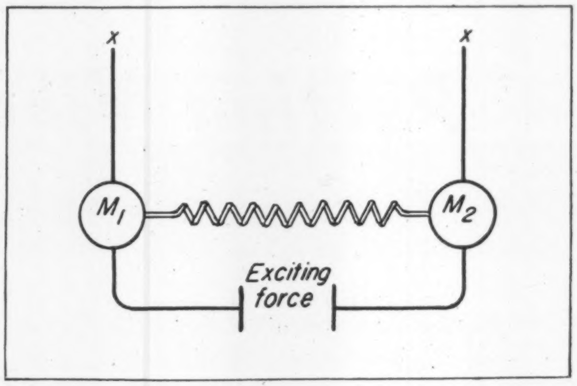


Fig. 4—Elementary vibrating system consisting of two freely supported weights connected by a spring

Tuning: Except for the types in which vibration is produced solely by an eccentric, all vibrators rely to some extent on the natural resonance of a system of two weights coupled together by a spring to obtain reasonable vibrations, *Fig.* 4.

If the exciting force is exactly in step with the natural frequency at which the system vibrates (resonant frequency) full vibration will be obtained with extremely little power input. However, under these conditons, should a heavy load be placed upon the vibrating surface the damping effect of the load will be considerable, and the vibration may be much reduced. The farther from the natural frequency of resonance the frequency of the exciting force is, the greater is the power required to maintain full vibration when unloaded, but the "stiffer" (or less affected by load) will that vibration be. In practice it is never necessary to depart more than a small amount from the natural frequency of resonance in order to obtain as stiff a vibration as is likely to be needed.

It follows that it is very important to determine the relationship between the strength of the spring, the two weights, and the natural frequency of resonance. Let K be the spring scale expressed in pounds per inch deflection, and let M_1 and M_2 be the two weights, and f or $2\pi\omega$ the natural frequency of resonance, *Fig.* 5.

If the system is disturbed and oscillates freely, neglecting damping, and if at time t the weights M_1 and M_2 are x_1 and x_2 inches from their mean positions, the extension of the spring will be $x_1 + x_2$ which, because the motion will be simple harmonic, will be called $Y \sin \omega t$. Then the force exerted by the spring will be $KY \sin \omega t$. Therefore

$$M_1\frac{d^2 x_1}{dt^2}=K\,Yg\sin\omega t$$

Solving the differential equation,

$$x_1=-\frac{K\,Yg}{M_1\omega^2}\sin\omega t$$

If X_1 is the maximum value of x_1, and X_2 the maximum value of x_2

$$X_1=\frac{K\,Yg}{M_1\omega^2}\text{ and }X_2=\frac{K\,Yg}{M_2\omega^2}$$

Therefore

$$\frac{X_1}{X_2}=\frac{M_2}{M_1}$$

In other words, the weights share the vibration in inverse proportion to their values. Also $X_1 + X_2 = Y$, therefore

$$\frac{KYg}{M_1\omega^2}+\frac{KYg}{M_2\omega^2}=1$$

and

$$Kg\frac{M_1+M_2}{M_1M_2}=\omega^2$$

or

$$Kg=\frac{M_1M_2}{M_1+M_2}\omega^2$$

This equation connects the spring scale, the two weights and the frequency at which the system will naturally vibrate.

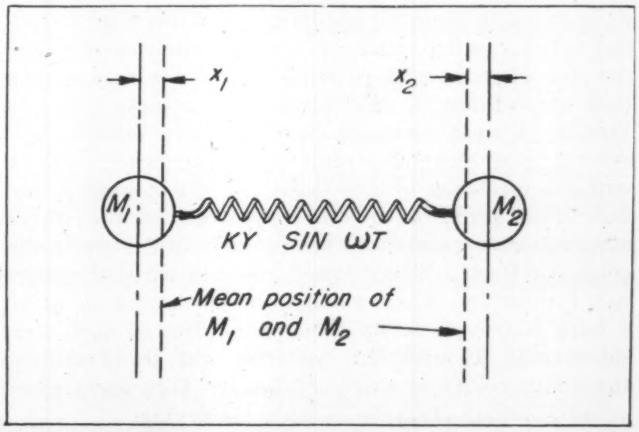
EXCITATION: By "excitation" is meant the application of the necessary impulses to maintain a vibrating system in a steady state of vibration. Excitation can be applied mechanically, hydraulically, pneumatically, or electrically. Mechanical, hydraulic, and pneumatic excitations are more popular for large vibrations at low frequencies. Electrical excitation is more suited to smaller vibrations at higher frequencies. There is no hard and fast border line, and many factors will affect the choice made.

Mechanical excitation is generally produced by some form of out-of-balance weight, driven by either motor or lineshaft through flexible belting or a flexible coupling.

Hydraulic excitation is produced by a reciprocating piston moved by high-pressure fluid which is caused to oscillate in a high-pressure pipe line by a motor-driven ram pump.

Pneumatic excitation uses a constant-pressure air supply, the air being admitted alternately to either side of a moving plunger by an oscillating valve, and exhausted to the atmosphere.

Fig. 5—Diagram showing instantaneous position of a simple vibrating system during the cycle



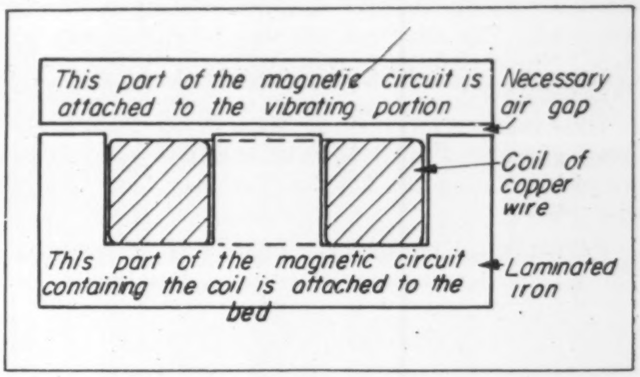

This part of the magnetic circuit is attached to the vibrating portion
Necessary air gap
Coil of copper wire
This part of the magnetic circuit containing the coil is attached to the bed
Laminated iron

Fig. 6—Sectional elevation of electric exciting unit. Many alternative magnetic circuits are possible

Electrical excitation is produced by a magnetic circuit, with an air gap, one portion of the magnetic circuit being mounted on the vibrated portion and the other on the relatively stationary portion, or "bed", *Fig.* 6. At least one coil will be mounted on the iron circuit and may be fed with any of the following:

1. Interrupted direct current
2. Alternating current, *Fig.* 7
3. Half-wave rectified alternating current
4. Alternating current with direct current superposed; alternatively one or more coils carrying alternating current and one or more coils carrying direct current.

Reviewing the characteristics of these various systems from an electrical point of view, it is an advantage if the load imposed on an alternating current electrical system is of good power factor and loads all the phases equally. Apart from this, low cost is likely to be the most important consideration; and here each drive has to be considered on its merits, bearing in mind that initial cost may be very different from ultimate cost, and that from the maintenance aspect there is something to be said for the elimination of sliding or rolling surfaces, even when well lubricated, and of vibrating wire-wound magnet coils, although both can be made thoroughly well-wearing. The use of mechanical parts not specially designed to withstand the fatigue produced by heavy vibration will always prove expensive.

MECHANICAL EXCITATION: With mechanically excited vibrators, if any control is provided while running, it will operate by controlling the speed of the drive. At standstill, out-of-balance weights and springs may be changed. As the frequency of forced vibration approaches the natural resonant frequency the vibration amplitude will increase, but the damping effect of load will also increase. It should be made impossible for the vibration, when running light, to exceed the permissible maximum for which the springs are designed. Should the application of maximum load damp the vibration to an insufficient value, the out-of-balance weight should be increased and the frequency of forced vibration should be kept further from the natural resonant frequency by adjustment of weights or springs or speed of drive so that the maximum safe vibration will again not be exceeded. The vibration will now be stiffer than before. The correct amount of stiffness can only be obtained by trial.

HYDRAULIC EXCITATION: With hydraulically excited vibrators control may be obtained by a needle valve, regulating the fluid oscillations at the vibrating "motor".

PNEUMATIC EXCITATION: Control of a pneumatically excited vibrator is effected by variation of the air supply pressure by means of a suitable valve.

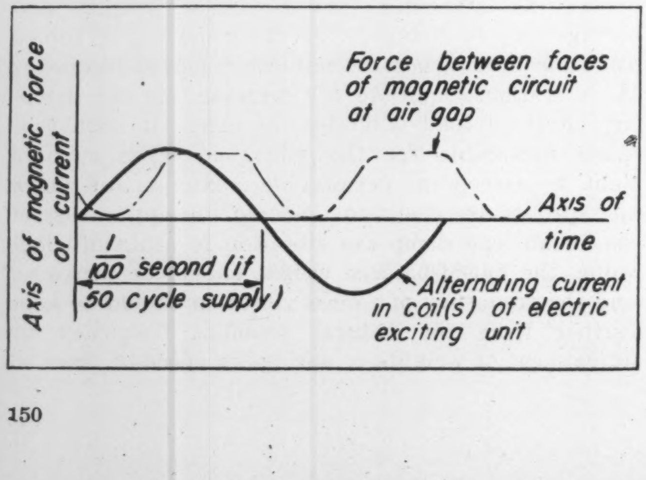
ELECTRICAL EXCITATION: With electrically excited vibrators control may be provided as follows:

1. *Interrupted Direct Current*
   a. By adjusting the length of the make-and-break gap
   b. By series resistance regulation
   c. By adjustment of spring strength or vibrated weights.
2. *Alternating Current*
   a. By regulation of the applied voltage by the following three methods, all of which are remote methods of control:
      i. Series regulation
      ii. Moving coil or induction regulator
      iii. Alternating field regulation (if there is one alternator to one vibrator)
   b. By changing tappings on the vibration coils
   c. By adjusting spring strength or vibrated weights
3. *Half-wave Rectified Alternating Current*
   The same as for alternating current, except that power factor cannot be advantageously improved with condensers
4. *Alternating Current with Direct Current Superimposed*
   a. By regulation of a-c voltage by:
      i. Alternator field regulation
      ii. Moving coil, induction regulator or other means
   b. By regulation of d-c superposed current by:
      i. D-c generator field regulation
      ii. Series regulation (which also has a small effect on the a-c component)
      iii. If full-wave rectification is used, by transformer tap changes, moving-coil regulator, or induction regulator
   c. By changing tappings on vibrator coils
   d. By adjusting spring strength or vibrated weights.

"PUSH-PULL" EXCITATION: With normal electrical excitation only one impulse is given in each complete cycle of vibration. For high-frequency vibrations (40 per second and over) this is satisfactory even when heavy loads are imposed. But for lower frequency vibrations at larger amplitudes, such as 1/8-inch or more, the damping effect of heavy load becomes increasingly serious.

To meet this difficulty, a design has been developed which provides one impulse every half-cycle of vibration. This is achieved by mounting two magnets in flat opposition with a common armature between them. The coils are so connected that the flux in one magnet is at its maximum at the moment at which that in the other magnet is at its minimum, and vice versa. Two positive impulses are, therefore, given to the vibrating system in each complete cycle of vibration and, therefore, the damping effect of heavy loads is considerably overcome.

Fig. 7—Approximate time graphs of ac-current and magnetic force, showing "doubling in frequency" effect



GOOD CONTROL is the most important factor in the success or failure of a vibrating drive. In general, means should be provided to make it impossible to exceed the maximum permissible vibration, and regular, preferably infinitely variable, control should be provided from a low value of vibration up to the permissible maximum. Where the drive is in a dusty or dirty situation remote control is very desirable.

Multiple Drives

MECHANICAL COUPLING: Although the manufacturers of vibrating units have developed a wide range of "frame sizes", it is often convenient to fit several vibrators to one drive. There are two distinct cases: Closely and loosely mechanically coupled drives.

A long conveyor is an example of the first case when more than one drive is fitted, all the drives being in tandem. A vibrating screen supported on each side or at each corner by a vibrator is an example of the second case. The frame of the screen forms a relatively loose mechanical coupling between the units.

When drives in parallel are mechanically coupled, care must be taken to see that they do not oppose one another instead of assisting one another. Long conveyors are frequently fitted with a large number of vibrating units. Should one unit have to be electrically disconnected during the course of maintenance work, it may not be at all difficult for it to be incorrectly reconnected, in which case its vibrator may be 180 degrees out of phase with the remaining vibrators. If a generous number of vibrators have been fitted the opposition of one of them may be unnoticed for some time, by which time mechanical damage may have been done. It is for this reason that importance should always be attached to the supply of good terminal boxes, clearly marked terminals, and clear diagrams of connections. Even without mistakes of this kind, careful consideration should be given, with long conveyors, to the waves of compression and more particularly of flexure in the conveyor itself. Cases have arisen in which fracture has repeatedly taken place at a particular point in a long conveyor, solely through neglect of such consideration. In addition, material will stand still at the nodal points of waves of flexure, forming a more or less serious obstacle to good conveying.

MACHINE Editorial DESIGN

Industrial Styling Needs New Emphasis

Although designing for appearance has made great strides since the end of the war, it still has a long way to go. This applies particularly to machines used in the industrial and processing fields. Designers of consumer machines for the home and office not only have been more keenly aware of the value of appealing to the potential buyer from the standpoint of utility but also have kept closely in mind the generally accepted impression that "when a machine looks good it is good".

This does not mean that consideration of styling has been entirely neglected in other fields. Representative examples of modern industrial design were to be seen, for instance, at the recent Machine Tool Show in Chicago. A definite trend was noticeable toward the development of machines that not only are "cleanlined" in appearance but which also incorporate invaluable factors such as ease of control, safety in operation, and ease of maintenance.

Designers of all types of machines, regardless of the industry or field for which they are intended, should be alert to the advantages to be gained by taking into account industrial design considerations during the early stages of development. More and more importance unquestionably will be given this aspect of design. Technical schools and colleges are taking it up and at one of the leading universities on the West Coast a complete course on industrial design now is being offered.

Looking into the future, the time may not be too distant when practically every engineering department in the country will have its own specialists—or outside consultants—on industrial design matters.

Materials Work Sheets

Because the specification of materials is one of the major responsibilities of the designer of machines, readers of this journal have welcomed the publication of the Materials Work Sheets compiled by Richard K. Lotz and presented as a regular feature of the magazine since October 1943. Innumerable letters of commendation received throughout this period bear ample testimony to the effectiveness of the series as a whole and to the value, to the designer, of each individual Work Sheet. It undoubtedly will be good news to readers to hear that the complete series of Materials Work Sheets—the last one of which appears in this issue—is to be made available shortly at nominal cost in permanent book form.

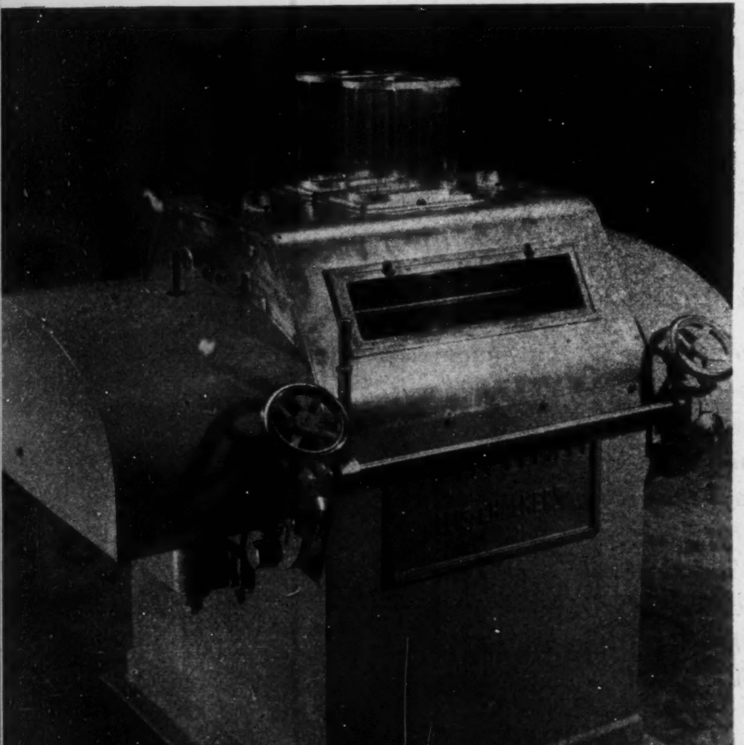
L. E. Jermy

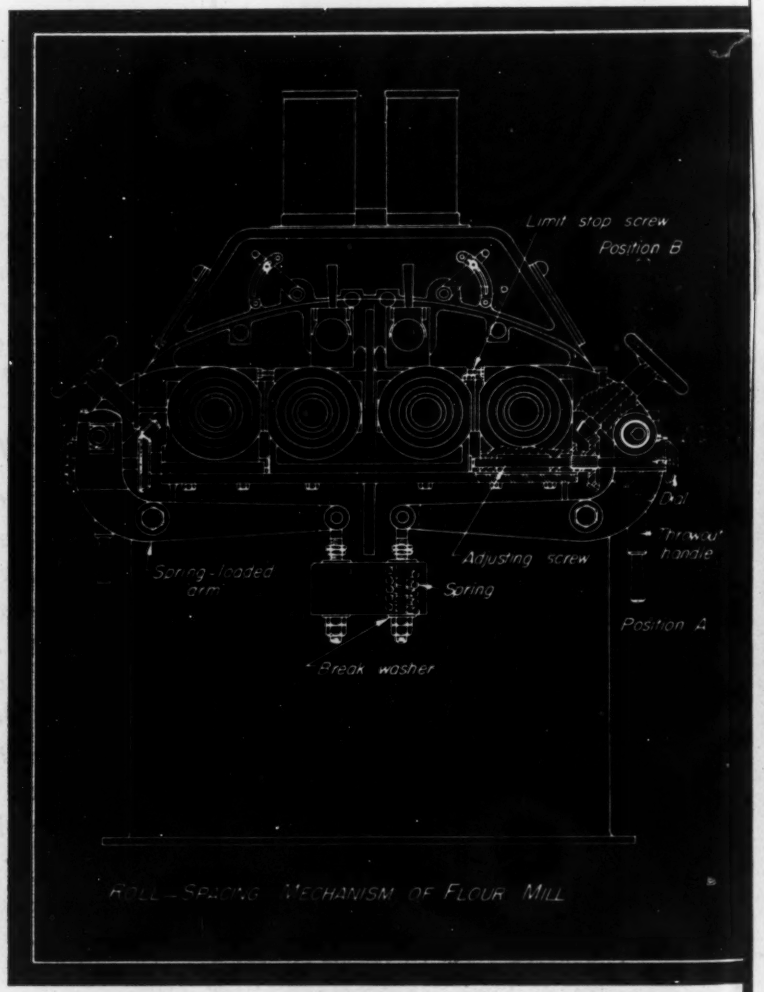
DESIGNS OF THE MONTH

Micrometer Adjustment Controls Roll Spacing in Flour Mill

OPERATION of this mill is centered around four rolls, mounted in pairs. For a crushing and rubbing action the rolls of each pair are run at different speeds. When crushing or flaking action is required, the rolls are driven at the same speed. The two inside rolls are mounted in fixed bearings whereas the outside-roll bearings are adjustable in V guides on the machine base. A spring-loaded pivoted arm maintains roller pressure at whatever roll spacing has been established by the handwheel-actuated adjusting screws. Outer roll of each pair can be moved quickly out of operating position by means of the throwout lever which actuates an eccentric shaft, the bearing of which is mounted in a block sliding in a pocket at the end of the spring-loaded arm.

Rolls are prevented from touching by means of limit stop screws which are set to fix the roll spacing at the desired minimum. Dials at ends of the adjusting screws are graduated in thousandths of an inch and indicate the distance of roll spacing at all times. Purpose of spring loading the rolls is to permit the rolls to spread in the event foreign matter such as nuts, bolts, etc., are accidentally dropped into the rolls. The break washer will break if the spring is unable to permit the rolls to spread sufficiently for passage of large foreign matter. Manufacturer: Allis-Chalmers Manufacturing Co., Milwaukee 1.



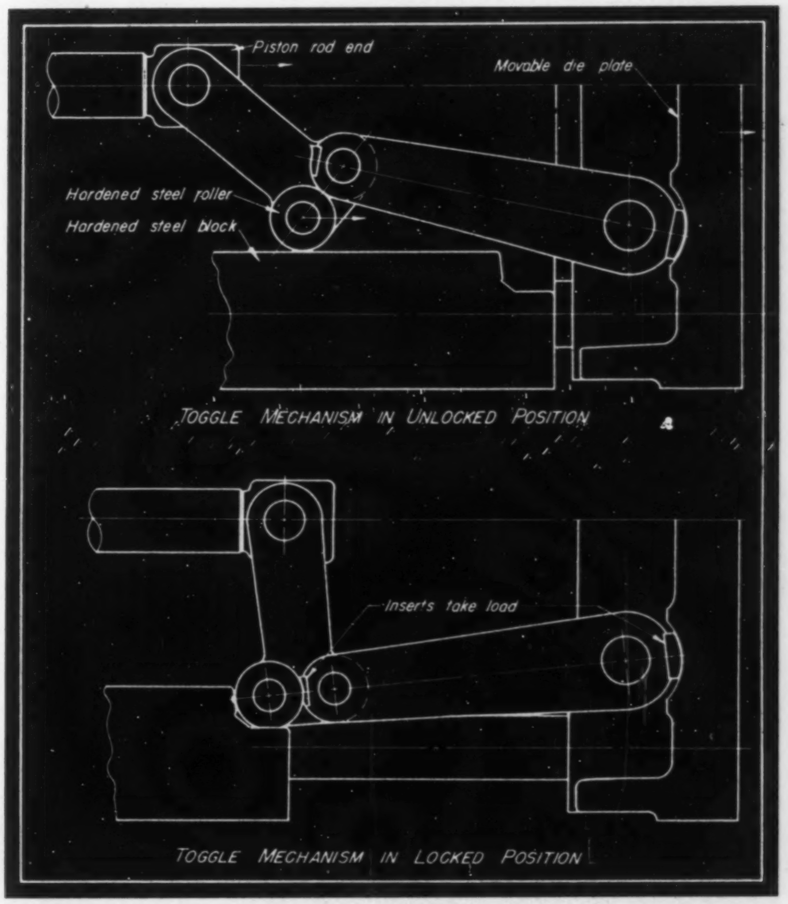


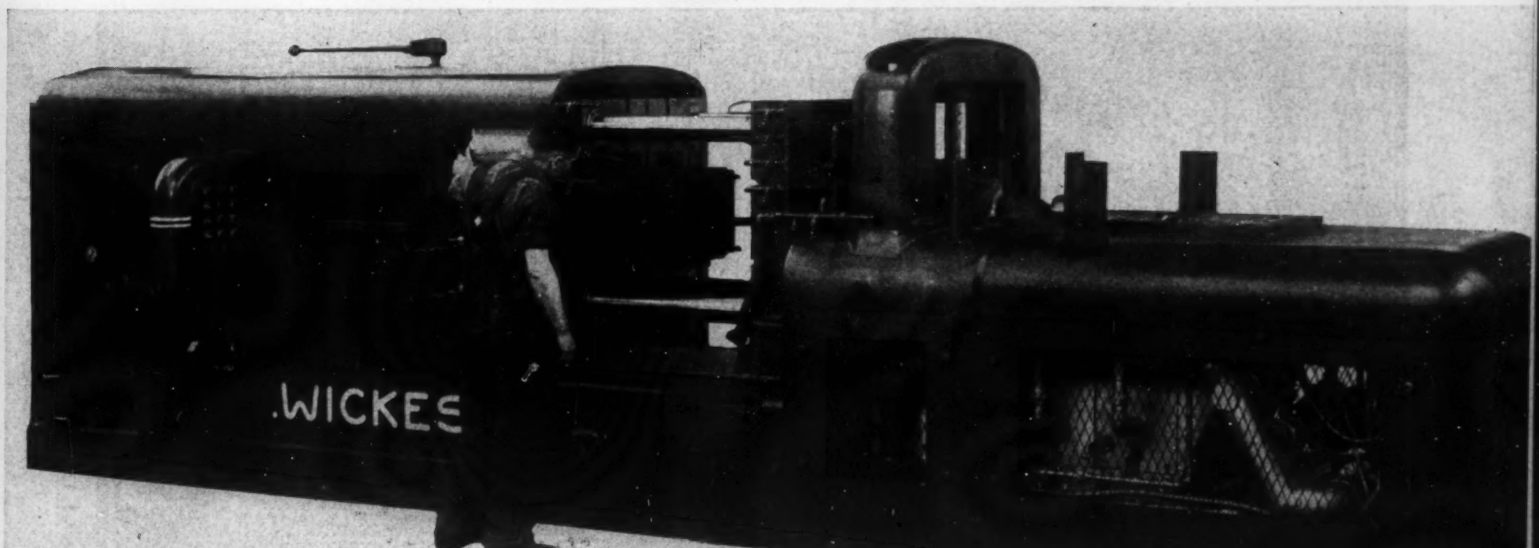
ROLL-SPACING MECHANISM OF FLOUR MILL

Novel Toggle Mechanism Actuates, Locks Platen in Die Casting Machine

INTERESTING toggle arrangement in the automatic die casting machine, below, drives the movable die plate to "closed" position and locks it there. Power for actuation of the four toggles, one of which is shown in the drawing, right, is supplied by a hydraulic cylinder. As the die plate is driven from "open" position (top view of drawing), the hardened steel roller rides along the polished surface of the hardened steel block until the pocket at the end of the block is reached. Further movement of the piston rod drives the roller into the pocket and, with the roller shaft acting as a fixed pivot, forces the toggle arms into the locked position. The inserts shown serve to relieve the toggle pins of the locking load and establish a solid metal-to-metal contact along the straight load line. Die locking pressure is estimated at 500 tons.

Quick injection pressure is supplied by a heavy-duty accumu-


Piston rod end
Movable die plate
Hardened steel roller
Hardened steel block
TOGGLE MECHANISM IN UNLOCKED POSITION
Inserts take load
TOGGLE MECHANISM IN LOCKED POSITION

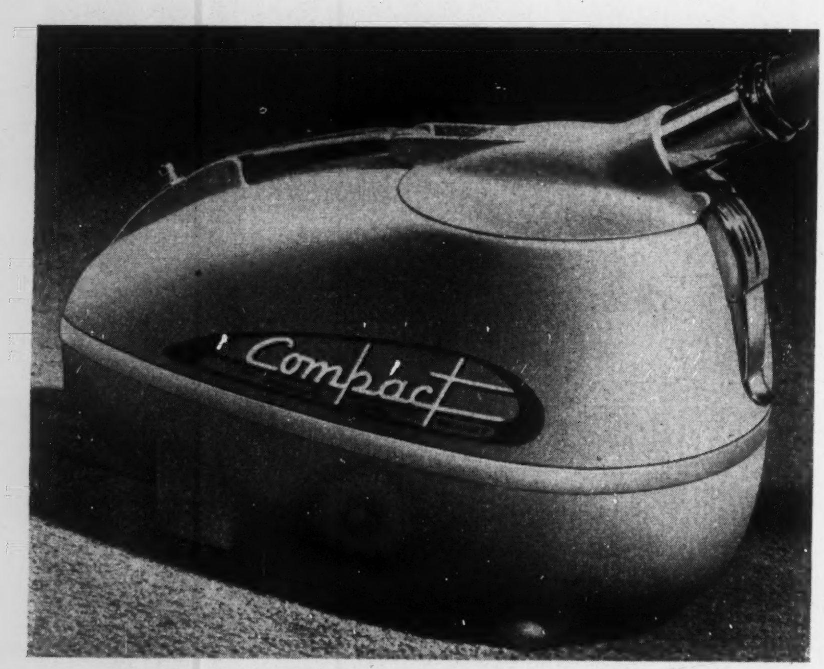


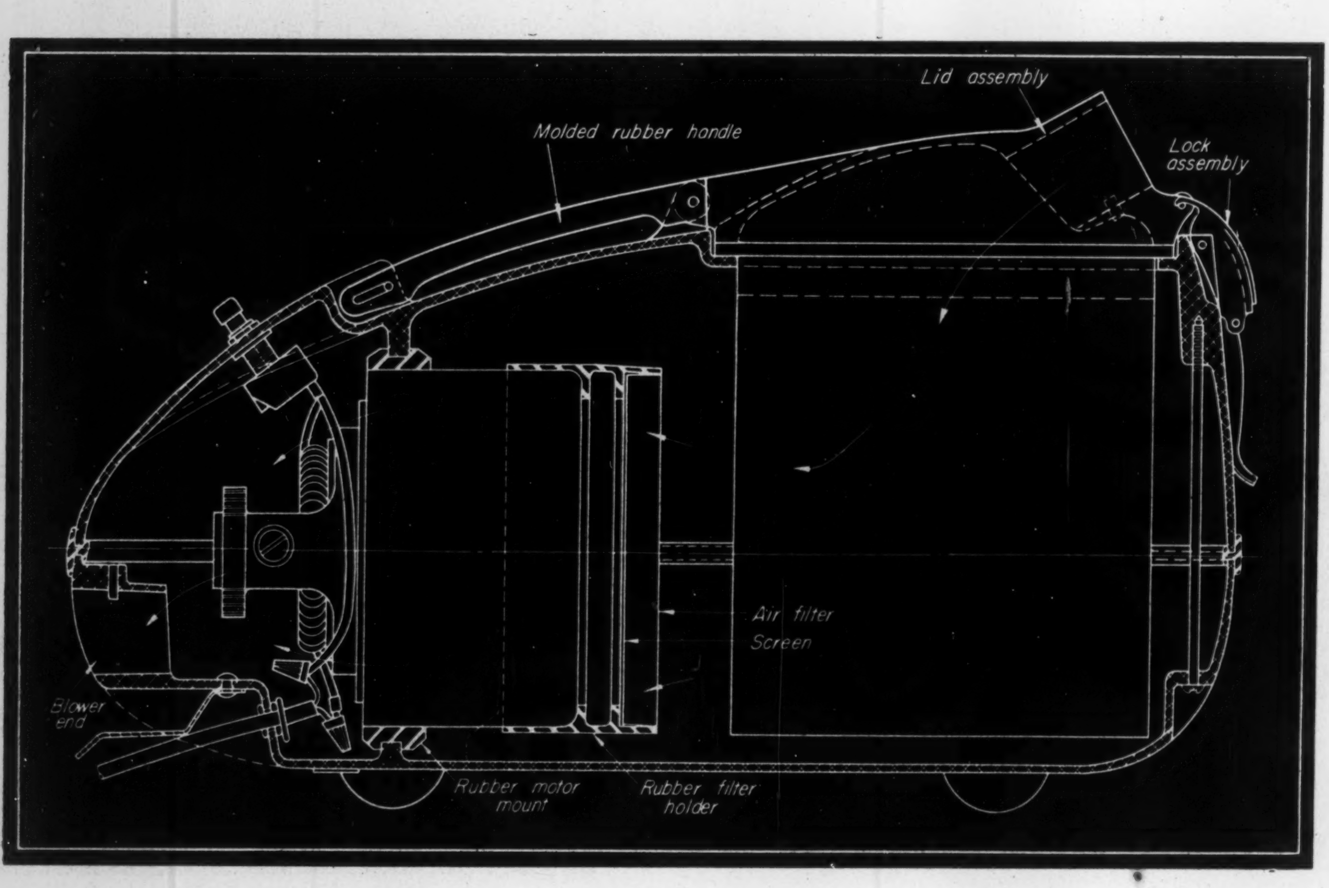
lator to twin hydraulic cylinders. Through an arrangement of bevel-gear-driven worm gears, internally threaded to mesh with threads on the four tie rods, positioning of the platen is effected from a single crank. Machine is controlled by automatic electric timers and has solenoid-operated hydraulic equipment throughout. All moving parts are automatically lubricated. Manufacturer: Wickes Brothers, Saginaw, Mich.

Vacuum Cleaner Employs Vertical Dust Bag

MODERN clean-line styled, this compact vacuum cleaner has a vertically hung dust bag to facilitate handling. Lifting of the hinged lid permits quick insertion or removal of the bag. The 1/3-hp universal motor is rubber mounted to reduce noise and vibration and incorporates twin aluminum fans which are dynamically balanced. Motor armature core is laminated iron wound with double-dipped, baked enamel wire to insure imperviousness to moisture. Air from suction end of machine is filtered before passing through the motor and out the blower end.

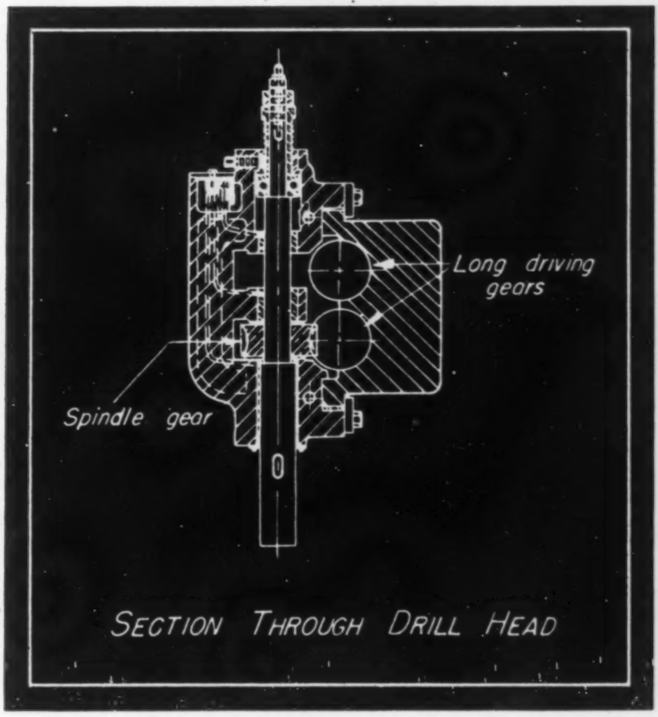
Case of the cleaner is permanent-mold aluminum alloy and will support a 1000-pound weight without cracking. Two rubber wheels and two glider bosses support the entire unit which is finished all over in gray wrinkle baked enamel. Lid latch is chrome-plated steel and a gray rubber bumper strip encompasses the entire machine. Total weight of machine, less cord, is fifteen pounds. Manufacturer: Interstate Engineering Corp., El Segundo, Calif.



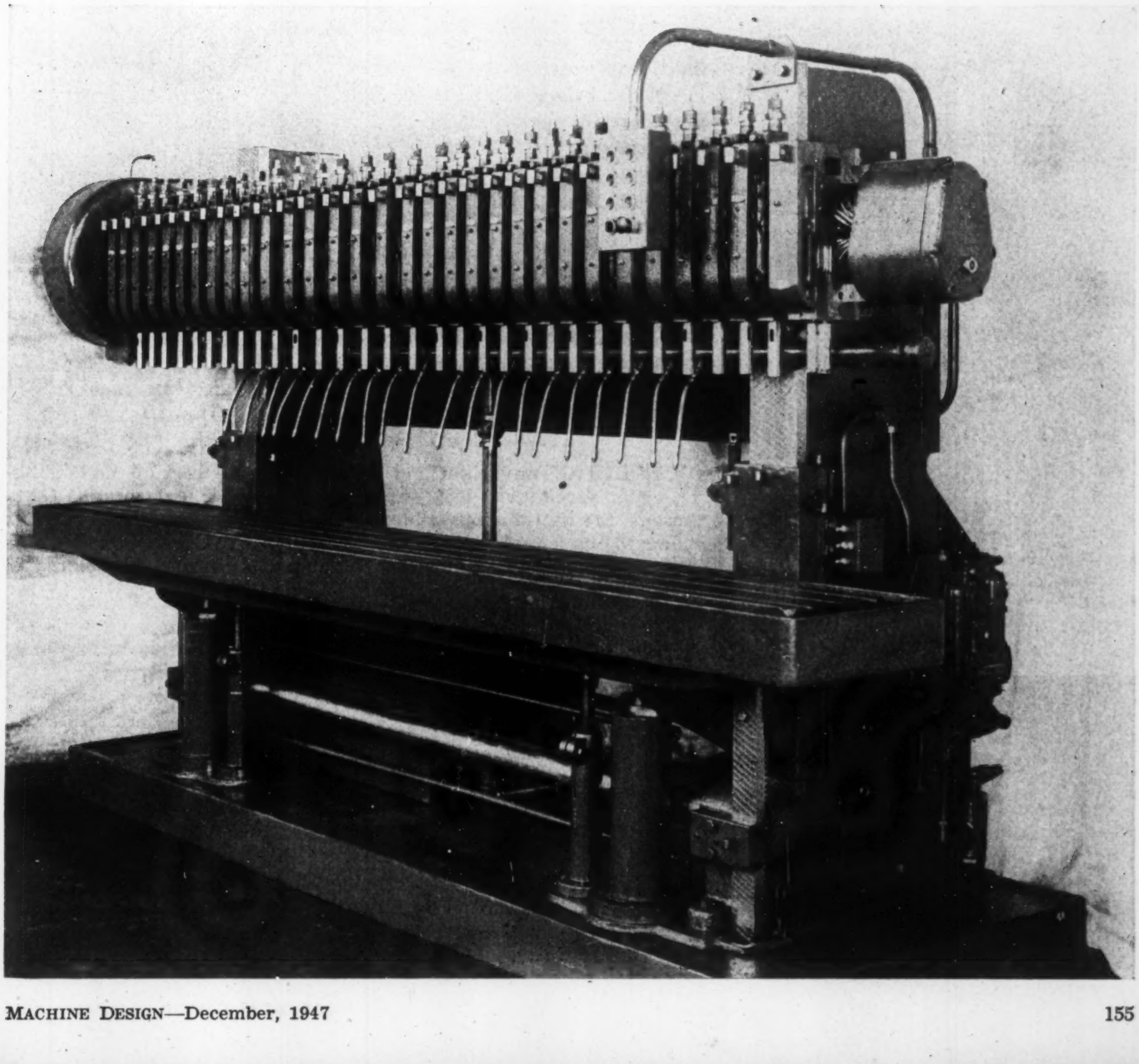


Spiral Gear Drive Facilitates Drill Head Spacing

OPTIMUM simplicity is achieved in the drill head drive of this straight-line production drilling machine. Spiral gears ranging in length from six to ten feet, depending on machine size, are used as common driving members to all drill heads. These long spiral gears mesh with the individual spiral gears mounted on the spindles of all drill heads. This arrangement permits infinitely variable spacing of the drill heads and, in addition, makes possible spindle-to-spindle spacing of adjacent drill heads as close as ¾-inch. Speed of the long spiral driving gears can be changed through a change-gear arrangement in the gear box. Rapid traverse and feed of the machine table are hydraulically actuated and controlled. Table is provided with T-slots for fixture mounting. Manufacturer: Moline Tool Co., Moline, Ill.



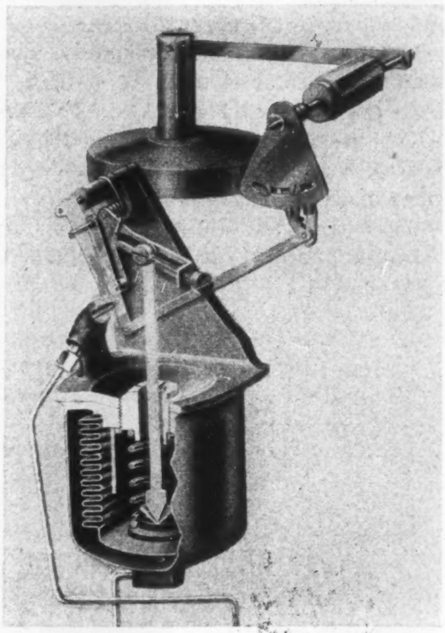
SECTION THROUGH DRILL HEAD



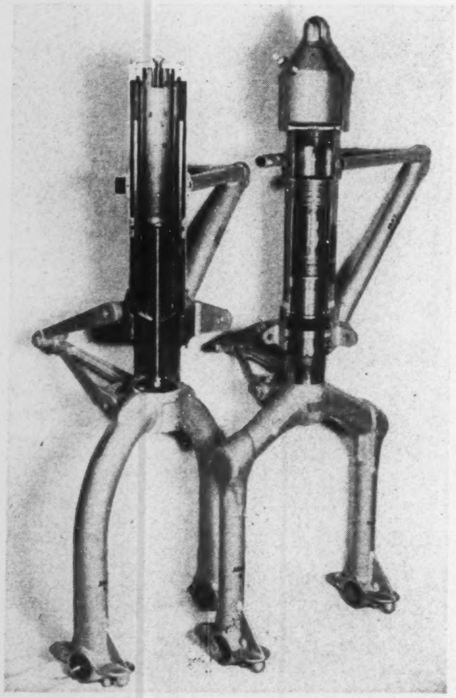
Applications

of engineering parts, materials and processes

Motion Transmitted by Bellows

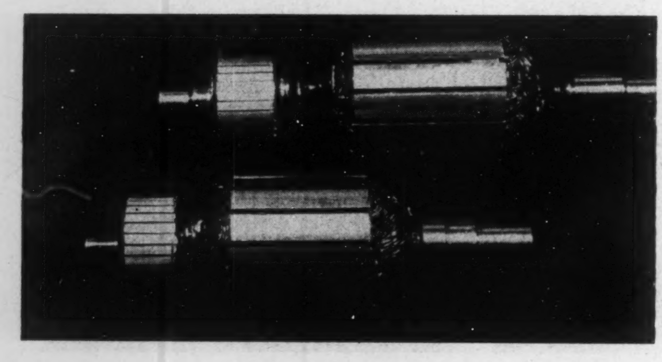


BELLOWS are used for data transmission in the Brown Instrument Company's New-Matic remote transmission. Instrument, right, consists of three elements: Float and linkage, bellows assembly, and pneumatic valve assembly. Vertical motion of the float results from change of flow velocity in pipe or chamber (not shown). This motion, transmitted by a linkage, produces a change in air pressure in the bellows chamber. Error-detecting linkage balances the pressures within and outside the bellows until the bellows position, and thus air pressure, is a measure of the new rate of flow. Since the receiver is an identical bellows unit, pneumatically linked with transmitter system, its final position is the same as that of the transmitting bellows. Simple bell-crank linkage connects receiver bellows rod to pen of recording device, where continuous record of flow rates is made. Receiver is actually, therefore, a pressure gage.



Brazing Reduces Weight

REDUCTION in weight and in manufacturing cost of the landing-gear shock strut, left, was achieved by the Beech Aircraft Corp. through the use of silver-alloy brazing. The new all-brazed strut is shown to the left of earlier design which was not assembled by brazing. Use of simplified components was made possible by the brazing technique.



Varnish Resists High Stress

LIFE of high-speed motors, rotors for which are shown at left, has been increased greatly through the use of thermosetting high-temperature varnish on the windings. Designed for driving portable tools, these Westinghouse motors are of universal type and run at 8000 to 10,000 rpm when fully loaded. Load removal also imposes severe centrifugal stresses on rotor. Also, in usual service, motor is subjected to continual vibration. The thermosetting varnish withstands these extreme conditions.

New High-Speed Helical and Herringbone Gear Standard

ALTHOUGH ISSUED for use primarily in the design of self-contained speed-reducer units, the new AGMA standard practice presented in this Data Sheet through the courtesy of the American Gear Manufacturers Association will be found equally valuable in the design of other types of high-speed helical gear drives falling within this classification

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THIS standard practice covers enclosed high-speed helical and herringbone, simple train, gear drives of the parallel-shaft type. Units in this classification are those operating with pinion speeds of 3600 revolutions per minute and higher, or pitch line speeds of 4000 feet per minute and higher, or journal velocities of 1500 feet per minute and higher. Marine propulsion gearing, however, is in a separate category and is not covered by this standard.

The responsibility for satisfactory operation is assumed by the manufacturer, provided that the gear unit is properly installed and lubricated and that the entire system of rotating parts is free from serious critical speeds and torsional vibrations, and that the transmitted loads are within the limits for which the gear unit was sold.

Design of Gearing

Gear materials to be in accordance with AGMA Standard "Gear Materials—Steel" 241.01. The Brinell hardness of the gear is to be 180-225 and the pinion 225-265.

Any practical combination of tooth height, pressure angle, or helix angle may be used; however, it is recommended that they be made in accordance with AGMA Standard "Tooth Forms—Helical and Spur" 201.01.

Tooth runout, spacing, lead, etc., to be in accordance with AGMA Standard Inspection "Helical and Herringbone Gears" 231.01.

Any relation of center distance and face width may be used providing there is no undue concentration of pressure arising from deflection under load. The combined torsional and transverse deflection curve within the face width of the pinion shall not deviate from a line parallel to the shaft more than 0.001-inch for first reduction pinions and 0.0015-inch for second reduction pinions.

The horsepower rating for surface durability shall be obtained from the equation:

$$P = C^2 F n M K$$

where C = Center distance (inches)

F = Face width of gears (inches)

n = Pinion rpm

$$M = \frac{m_G}{(m_G+1)^3 \, 31{,}500}$$

$$m_G = \text{Gear ratio} = \frac{\text{number of teeth in gear}}{\text{number of teeth in pinion}}$$

K = Service classification factor from TABLE I for normal duty based on the maximum continuous load to be transmitted

$$K = \frac{W}{D_p} \times \frac{m_G+1}{m_G}$$

where W = Tooth load (pounds per inch of face)

D_p = Pitch diameter of pinion (inches)

High-speed gears need not be checked for strength rating because this will always exceed the durability rating.

Design of Gear Unit

The influence of housing, mountings, etc., upon the load-carrying capacity requires that the following be observed:

Housing may be of any of the commonly used designs providing it is sufficiently rigid to substantially maintain shaft positions under maximum loads for which it is intended.

Shafts may be journaled in ball, roller or sleeve bearings, but the bearings should be positioned so as to reduce the span and deflection to a minimum. They must be of a size and type approved by the bearing manufacturer for the application, mounting and lubrication.

Where sleeve bearings are used, they must be of the precision type and adequate provision must be made for their lubrication. Bearing pressures shall conform to established practices of the gear manufacturer.

The maximum torsional stress in any part of the shaft between journals shall not exceed 66.6*K*, where *K* is constant to be obtained from TABLE I. The maximum torsional stress at the coupling fit allowing for stress concentration due to changes in shaft sections and the effect of keyways is to be based on the nominal diameter of the shaft and shall not exceed 17 per cent of the yield point of the shaft material (approximately 0.509*K* times Brinell hardness number) where *K* is constant to be obtained from TABLE I.

Foundation and bearing bolt stresses must be within the limitations contained in AGMA Standard "Bolting—Allowable Tensile Stress" 255.01.

Provisions must be made for cooling the oil in the unit to keep the temperature of the oil coming from the unit within a maximum of 185°F.

Lubrication

For gears driven by any prime mover other than steam turbines or when a separate oiling system is maintained for the gear unit, refer to AGMA Standard "Lubrication of Enclosed and Open Gears and Gear Units" 250.01.

For gears driven by steam turbines and for which a common oiling system is maintained, the lubrication practice will be determined by the turbine manufacturer in conjunction with the gear unit manufacturer.

Marking

The use of the AGMA monogram is restricted to manufacturers who have received proper authorization according to AGMA Standard "Marking" 290.01 and to gear units designed and made according to this Standard 421.02.

TABLE I—K Values

Driven Machine	Electric Motor	Steam Turbine	Internal Comb. Eng.
Compressor—Centrifugal	85	85	63
Compressor—Rotary	63	63	55
Compressor—Refrigerant Air Conditioning Service	90	..	..
Fan—Forced Draft	85	85	70
Fan—Induced Draft	75	75	63
Generator	..	110	63
Pump—Centrifugal circulating	95	95	75
Pump—Descaling (with Surge Tank)	55	55	..
Pump—Pipe Line (Centrifugal)	75	75	63
Pump—Waterworks (Gen. Purpose)	75	75	63

MACHINE DESIGN'S

MATERIALS WORK SHEET

FILING NUMBER
7.07

Gray Iron Castings

ASTM Spec. A48-46

A.S.T.M. Specification A48-46 is recognized generally throughout industry as standard for machine castings of gray iron. Inasmuch as the machine designer most often is concerned primarily with mechanical properties and inasmuch as different foundries can produce gray iron castings of different compositions to meet identical property requirements, the ASTM specification is based on tensile strength rather than composition. For special applications, requiring unusually high heat or corrosion resistance, damping capacity, etc., it is suggested the designer solicit the advice of a competent foundryman

TENSILE PROPERTIES
(*ASTM Specification A48-46*)

Class of Gray Iron	Tensile Strength (min, psi)
No. 20	20,000
No. 25	25,000
No. 30	30,000
No. 35	35,000
No. 40	40,000
No. 50	50,000
No. 60	60,000

TRANSVERSE PROPERTIES
(*ASTM Specification A48-46*)

	——Breaking Load at Center of Test Bar——		
Class of Gray Iron	Test Type I* (min, lb)	Test Type II* (min, lb)	Test Type III* (min, lb)
No. 20	900	1800	6000
No. 25	1025	2000	6800
No. 30	1150	2200	7600
No. 35	1275	2400	8300
No. 40	1400	2600	9100
No. 50	1675	3000	10300
No. 60	1925	3400	12500

* Test Type I: Test bar diam=0.875 in.; span length=12 in.
Test Type II: Test bar diam=1.2 in.; span length=18 in.
Test Type III: Test bar diam=2.0 in.; span length=24 in.

CHARACTERISTICS

From a practical standpoint, the fundamental difference between gray cast iron and steel is the presence of free graphite particles in the cast iron. Gray iron consists essentially of a steel matrix throughout which there are minute graphite flakes. These flakes have little or no tensile strength and act like voids or holes within the structure.

The tensile properties of steels can be predicted from their hardnesses. While recent studies indicate that this is also possible with cast irons, further work must be done before generally acceptable factors are developed. In general, however, the strength of cast iron does increase with hardness. Gray cast irons have low ductility and, unless generous safety factors are allowed, are not ideally suited for shock loading. They have no well-defined elastic limit, but can sustain loads up to about 80 per cent of their tensile strength without failure. Modulus of elasticity at 25 per cent of ultimate strength, ranges from 12,000,000 psi for the weaker types to 30,000,000 psi for some alloyed types.

In general, shear strength varies from 1.0 to 1.6 times the tensile strength, with the lower tensile strengths having the higher ratios. Present data indicate that torsional strength ranges from 1.2 to 1.4 times tensile strength. Endurance limits of the gray irons average about 50 per cent of their tensile strengths, which ratio is comparable to that applying to steels. However, gray cast irons are not weakened as much by notches and grooves as are steels. Probably this is because the gray irons are inherently full of discontinuities (stress raisers) due to the graphite flakes, and addition of mechanical notching has no great additional effect. In general, gray iron castings offer the designer excellent vibration damping capacity.

Gray cast iron, under inadequate lubricating conditions, not only wears well on itself, but also on many other alloys, particularly when they are as hard or harder than the gray iron. Its resistance to seizure and galling is excellent. In general, the tensile strengths, hardnesses and endurance limits of gray irons change but slightly at elevated temperatures up to about 800 F. For service above this temperature, however, the ordinary gray

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MACHINE DESIGN is pleased to acknowledge the collaboration of the American Foundrymen's Association in this presentation.

irons seldom suffice, and alloyed types must be employed.

Ordinary gray cast irons have poor magnetic permeability and will not carry flux densities as high as will rolled steel. Their thermal conductivity, ranging from 0.100 to 0.140 cal/sq cm/sec/cm/deg C, is lower than that of steel, wrought iron and nonferrous metals. Their coefficient of thermal expansion averages about 0.000010 per degree Centigrade.

APPLICATIONS

Gray iron castings are used in practically all branches of the machine building industry. Some representative applications of the alloy types are given in the following listing:

Automotive Castings

Brake drums—wear and heat resistant
Camshafts—hard, strong, tough, wear resistant
Clutch plates—excellent wear resistance
Crankcases—strong, rigid, good machinability
Crankshafts—strong, shock resistant, good vibration dampening
Connecting rods—strong, shock resistant
Cylinder blocks—heat and wear resistant, good machinability
Cylinder heads—strong, heat and wear resistant
Cylinder liners—heat and wear resistant, satisfactory machinability
Cylinder sleeves—wear resistant
Exhaust manifolds—growth, heat and corrosion resistant
Gears—good strength, wear resistant
Pistons—strong, wear and heat resistant
Piston rings—wear and heat resistant

Chemical Equipment

Pump castings—corrosion resistant
Valve bodies, fittings—corrosion resistant
Pump impellers—corrosion resistant
Steam pressure castings—strong, wear and abrasion resistant

Compressors and Pumps

Bodies—wear resistant, pressure tight, good machinability
Crankshafts—wear and fatigue resistant
Cylinders—uniformly hard and dense
Flywheels—strong, ductile
Pump impellers—wear and abrasion resistant
Pump liners—dense, strong, wear resistant

Crushing, Grinding Equipment

Crusher frames—strong, rigid, good machinability
Crusher plates—tough, wear and abrasion resistant
Crusher rolls—abrasion resistant
Ball mill liners—abrasion resistant
Ore chutes—tough, abrasion resistant
Pug mill knives—abrasion resistant
Sand blast nozzles—abrasion resistant

Machine Tools

Beds, heavy duty—rigid, dense, wear resistant
Main columns—good finish, hard, wear resistant
Hydraulic cylinders—wear resistant, pressure tight, good machinability
Links, levers, arms—strong, good machinability

Railroad Castings

Air pump bushings—uniform structure, wear resistant, good machinability
Bull rings—uniform structure, wear resistant, good machinability
Cylinder bushings—uniform structure, wear resistant, good machinability
Cylinders—uniform structure, wear resistant, good machinability
Pistons—uniform structure, wear resistant, good machinability
Valve bushings—uniform structure, wear resistant, good machinability

FABRICATION

MACHINABILITY:

Ease of machining of gray iron castings generally is inversely proportional to their strength. Also, while there is no direct proportional relationship, ease of machining decreases with increasing hardness. Since gray iron castings may range from soft to chill hard, their machinability ranges from excellent to exceedingly poor. Completely annealed permanent-mold cast iron offers best machinability, while chilled or white cast iron is generally unmachinable and must be ground to finish shape and size.

WELDABILITY:

Two methods lend themselves most readily to the welding of gray iron castings. These are oxyacetylene welding with cast iron filler, and metal-arc welding with nickel or copper-nickel welding electrodes. Oxyacetylene welding is the fastest method of depositing metal and offers sound deposits and identical color match. When properly executed the welds are readily machinable and free from defects. However, since high preheats are required and casting distortion is difficult to control, this method is not applicable to castings which have been partially or completely machined before welding. Overall preheats ranging from 600 to 800 F are employed in conjunction with local preheats of about 1000 F. For best physical properties, the welding is done as rapidly as possible.

Metal-arc welding, while slow and tedious, is required on machined castings where distortion cannot be tolerated. Often preheating is not needed. Progressive peening of the weld metal is necessary as welding proceeds to prevent cracking and to hold dimensions. Where oxyacetylene welding will suffice, the metal-arc process should not be considered.

HEAT TREATMENTS

In a general sense, gray iron is comparable to steel in response to heat treatment. Four broad classifications of heat treatment are employed:

1. Stress-relief annealing
2. Annealing
3. Quenching and tempering
4. Special heat treatments

STRESS-RELIEF ANNEALING: Performed prior to finish machining, this treatment is used to relieve internal stresses induced by casting, quenching, normalizing, machining, cold working, or welding. Relief of internal stresses requires that the metal be heated to a temperature at which elastic properties will lower sufficiently to permit the internal stresses to cause plastic deformation. In plain cast irons this temperature range generally is 800 to 1050 F. The castings are held at temperature for about one hour per inch of section and slowly cooled in a furnace. The alloyed irons usually are heated to higher temperatures (approaching 1200 F). Hardness and strength are affected only slightly by stress-relief annealing. Another method of relieving internal stresses, still practiced, is "aging", which consists of merely storing the castings for weeks or even months before machining. However, the heating and cooling method is much quicker and more certain of controllable results.

ANNEALING: Purpose of this treatment is to soften castings and thus improve their machinability. It involves heating followed by cooling at a carefully controlled rate. Annealing always changes the as-cast structure, decreasing its physical properties. For this reason the degree of anneal must be controlled for specific applications. Temperatures are somewhat higher than those used for stress relieving, being in the neighborhood of 1200 to 1800 F.

QUENCHING AND TEMPERING: As is the case with steels, cast irons can be hardened and strengthened by a quenching and tempering heat treatment. The casting is heated, generally to a temperature from 1450 to 1600 F, and quenched in either oil or water—oil being employed in most cases. The quench, which leaves the casting hard, brittle and filled with internal stresses, is followed by reheating to a temperature below the quench temperature, after which the casting is slowly cooled. This reheating and slow cooling, known as tempering, relieves the internal stresses and toughens the casting, reducing its as-quenched hardness and brittleness. Tempering above 700 F improves tensile and transverse strength and increases hardness as much as 20 to 50 per cent above the as-cast strength.

Generally, castings to be hardened are rough-machined before hardening and tempering and are finished by grinding. A small amount of growth occurs on quenching, and allowance must be made for this by leaving stock for finish grinding. Where strength properties and shock resistance are not of particular importance, the tempering operation may be omitted.

SPECIAL HEAT TREATMENTS:

FLAME HARDENING: As the name indicates, flame hardening consists of heating portions of a casting progressively with a high-temperature torch, and quenching. Gears, cams, machine tool ways, sheaves, rolls, sleeves, liners and dies are being flame hardened on production schedules. Surface layers $\frac{1}{16}$ to $\frac{5}{32}$-inch in thickness may be hardened to from 450 to 600 Brinell. Depending on alloy content, quenching may be mild or drastic. Some alloy types may be hardened sufficiently by cooling action of the surrounding air and the cold metal beneath the heated zone. For more drastic quenching, water usually is employed. Because of the stresses set up during flame hardening due to the creation of unequal temperatures in the casting, a drawing treatment at 350-400 F generally is employed which effectively reduces the stresses and softens the metal only slightly.

INDUCTION HARDENING: In this process, selective surface hardening of a casting is effected through the concentration of high-power, high-frequency electro-magnetic current generating the heat in the surface to be hardened. Heating is extremely fast, time taken for each heating and quenching cycle being only a matter of seconds. Quenching medium employed generally is oil or water. Induction hardening is particularly applicable where large quantities of castings are to be surface hardened.

RESISTANCE TO CORROSION

Widespread use of cast iron for water main and soil pipe is a good indication of its generally favorable corrosion resistance. Many crude oils and their products are handled satisfactorily by cast irons, as is evidenced by the generous use by the oil industry of gray iron for pipe, valves and fittings.

Strong, dense grades of cast irons low in total carbon and silicon generally are most acid resistant. Sulphuric acid, 60° Baume or over, when not extremely hot, may be handled satisfactorily in gray iron. Exception occurs where high-purity acid is required and a trace of dissolved iron is objectionable. The attack of dilute sulphuric acid is rather rapid. Cast iron containers and lines carrying strong sulphuric acid must be sealed from air. If they are not, corrosion is likely to be severe.

High-silicon irons possess excellent corrosion resistance to many media. However, they are fragile, brittle, difficult to cast and almost unmachinable. Strong nitric acids and mixtures of nitric and sulphuric acid attack gray iron slowly. Dilute nitric acid attacks gray iron rapidly. Strong hydrochloric acid is not handled successfully in plain gray iron or the alloyed irons. Caustic and alkaline solutions are handled satisfactorily by gray iron and, in fact, even strong boiling caustic solutions attack gray iron only slightly. High-nickel, austenitic cast irons are even more resistant to caustics and alkalies than is ordinary gray iron—some grades are hardly tarnished by boiling caustic or lye.

The high-nickel, austenitic irons are resistant to most sulphuric acid, salt and alkaline solutions. Corrosion resistance of these irons is, in fact, superior to that of ordinary gray irons in all solutions in which they have been tested.

Work Sheets To Be Published in Book Form

The Materials Work Sheet on Gray Iron Castings in this issue concludes the series which was inaugurated in October, 1943. Interest evidenced during this four-year period indicates that the entire series has been of considerable value to designers throughout the country. To make the complete series available as a single integrated unit, it will be published in permanently-bound book form early in 1948. Further details, including cost, will be given in the editorial and advertising pages of subsequent issues of MACHINE DESIGN

Assets to a Bookcase

Design of Machine Members

By Alex. Vallance, Chief Designer, Reed Roller Bit Co., and Venton L. Doughtie, professor of mechanical engineering, University of Texas; published by McGraw-Hill Book Co., New York; 559 pages, 5½ by 8½ inches, clothbound; available through MACHINE DESIGN, $4.50 postpaid.

This book is a thorough reference work on the design of machine elements, covering its subject from welded and riveted joints to bearings and gears. Without going into the more advanced development and theory, it discusses design carefully and well. This is the second edition, the first having been published in 1938.

Numerous changes and revisions have been made, order of the chapters has been changed for better continuity in subject matter, and some chapters have been largely rewritten. To the excellent chapter on engineering materials has been added additional data on non-ferrous metals and such nonmetallic materials as plastics and synthetic rubbers. Well-organized, the book presents numerous typical problems to augment theoretical presentation, and devotes an entire chapter to the discussion of the design of members such connecting rods and flywheels.

☐ ☐ ☐

Explosion and Combustion Processes in Gases

By Wilhelm Jost, professor at the Physical Chemistry Institute, University of Leipzig; translated by Huber O. Croft, head, department of mechanical engineering, The State University of Iowa; published by McGraw-Hill Book Co., New York; 621 pages, 6 by 9 inches, clothbound; available through MACHINE DESIGN, $7.50 postpaid.

Translated from the German at the suggestion of the NDRC and the NACA, this work presents the theoretical basis of combustion substantiated in numerous instances by experimental data. Integrating theory and experiments from a wide variety of authoritative sources, the book considers carefully the preliminary stages and the origin of an explosion following through with the phenomenon of the completed combustion.

Typical topics covered are explosion limits, ignition processes in auto-ignition, explosion propagation speed, flame temperatures and the kinetics of combustion, and explosive processes. The volume gives careful study to combustion of premixed and nonpremixed gases and includes such helpful sections as chapters on the diesel and Otto engine.

The author has endeavored to provide an unbiased investigation of the field. Whenever seemingly contradictory data exists, he has presented that representing the various points of view. Since he has not attempted to write an exhaustive and comprehensive study of the subject, he has appended a careful bibliography of works in the field.

☐ ☐ ☐

Electrical Engineering

By Fred H. Pumphrey, educational service division, General Electric Co.; published by Prentice-Hall, Inc., New York; 369 pages, 6 by 9 inches, clothbound; available through MACHINE DESIGN, $5.35 postpaid.

Intended for use by engineers other than electrical, this volume may perhaps be best described by its subtitle—"Essential Theory and Typical Applications". Placing emphasis on basic physical concepts rather than on details of operating characteristics, the author has devoted the first eight of the sixteen chapters to essential theory. The remaining eight chapters deal with typical applications of this theory.

Inasmuch as the understanding of quantitative relationships and the ability to predict performance of machines depend largely on an appreciation of basic theory, these relationships have been set forth by means of numerous illustrative examples. In the first half of the book are covered such basic concepts as direct and alternating-current circuits, generators and motors, electron tubes, and circuits. The second section of the text discusses typical industrial applications such as heating, welding, measurement, control, and electrical communication equipment.

Exposure Tests of Nonferrous Metals

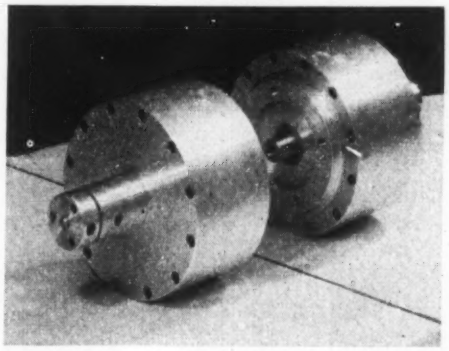
A book based on papers submitted at the 1946 spring meeting symposium on the subject of nonferrous metal corrosion has been published by the American Society for Testing Materials. Covering the corrosion of zinc, nickel, Monel and other copper alloys, lead, tin, and aluminum-base alloys as well as testing methods, the volume presents a welcome addition to knowledge of this trouble-some phenomenon. The 150-page symposium is available under the title "Atmospheric Exposure Tests of Nonferrous Metals" from the American Society for Testing Materials, 1916 Race St., Philadelphia 3. Heavy paper binding is $1.75, and cloth binding is $2.25.

new parts and materials

To obtain additional information on these new developments see Page 289

High-Speed Air Motors

Pneumatic motors for operation at speeds up to 3000 rpm are made in sizes from 4½ to 12 inches in diameter. While recommended for the speed limit stated, they have been operated satisfactorily at speeds up to 3500 rpm over long periods of time. Units are made from aluminum alloy forgings to reduce possibility of porosity. Manufacturer: Skinner Chuck Co., New Britain, Conn.



For further information circle MD 1 on card Page 289

Lightweight Oil Hose

Lightweight, flexible hose suitable for oil and gasoline usage is built around a carcass consisting of two plies of Ustex, a chemically treated textile 70 per cent stronger than cotton yarn. Hose is lined with a synthetic rubber which resists aromatics and high-octane fuels. Because of reduced outside diameter, standard size couplings may be used on this new hose. Manufacturer is the United States Rubber Co., Rockefeller Center, N. Y.

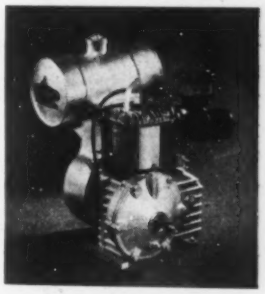
For further information circle MD 2 on card Page 289

Fractional-Horsepower Motors

Ventilated four-pole, shaded-pole motor is designed for a-c operation and is non-radio interfering. This type W motor has a large-cavity lubrication system which circulates oil through porous-bearings. The powder-metal bearings are said to retard gumming, filter the lubricant and provide an even flow of oil to the bearing surface at all times. Bearings are spring-tension centered and broadly spaced to provide smooth operation. Precision skewed, flush-welded rotor is accurately balanced and has machined surface. There are no open inductor slots to collect dust and chips. The 1/15-horsepower motor rotates at 1500 rpm when powered by 115-volt 60-cycle current. Housing length is 5⅛ inches, diameter is 3 15/16 inches. Units are recommended for use with air circulators, window-type ventilators, unit coolers, air conditioners, etc. Manufacturer: Redmond Co. Inc., Owosso, Mich.

For further information circle MD 3 on card Page 289

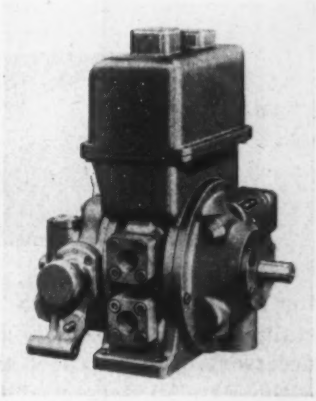
Four-Cycle Gasoline Engine



Lightweight 4-cycle gasoline engine is rated at 2.4 hp. This small engine has a centrifugal-type governor, and combined forced-feed and splash lubrication system. Unit, known as the Ultimotor, is recommended for use in powering pumps, compressors, garden tractors, lawn motors and other machines designed for lightness and portability. Manufacturer: Uebelhoer Brothers, Inc., 848 Kensington Ave., Buffalo 15.

For further information circle MD 4 on card Page 289

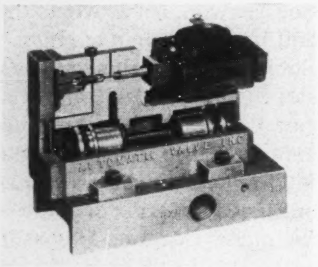
Variable-Speed Hydraulic Transmission



Compact electro-hydraulically controlled pump unit designed for use with hydraulic cylinders provides for feed adjustment over a 20:1 speed range. The new unit, known as type JK-10203, provides variable ratios from 13:1 to 265:1 between feed and rapid-traverse speeds, making possible great reduction in machine cycle time. When used with a double-acting cylinder, only two flexible tubes are needed to complete hydraulic system. No external directional control valves, feed control valves or associated high or low pressure piping are necessary. Electrical control operates from a manual station or from an automatic control panel. Possible feeds vary from 8 cu in. per minute to 3200 cu in. per minute with horsepower requirements ranging from 2 to 4. Manufacturer: The Oilgear Co., 1342 W. Bruce St., Milwaukee 4.

For further information circle MD 5 on card Page 289

Solenoid-Operated Air Valve

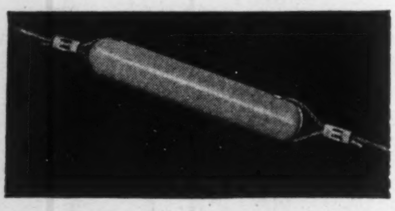


Compact 3-way, 3-port solenoid-operated air valve for controlling single-action air cylinders is known as the SV-3. New valve is light and compact, can be attached close to cylinders eliminating excessive piping and air waste. Mounted in any position it can be serviced easily without disturbing the piping. The unit, which is available normally open or normally closed, is a balanced-piston type valve, pressure-sealed and reversible in servicing and assembly. There are no metal sliding contacts owing to the use of O-ring seals. The valve operates on pressures from 5 to 150 psi, is available in ¼, ⅜, ½ and ¾-inch pipe sizes. Operating power demands are 1.42 amp at inrush and 0.22 amp sealed, operating from a 110-volt 60-cycle supply. Manufacturer: Automatic Valve Inc., 37415 Grand River, Farming-

For further information circle MD 6 on card Page 289

Cable Connector

Mechanical connector for fastening solid or stranded wires and cables of small diameter can be used to make eye splices and straight splices, and to attach wire ends to screws, studs, hooks, etc. Splices are made by inserting wire ends into barrel of the connector and crimping with a single operation of an installing tool. No solder, clamps or wire twisting is necessary. Two types of the connector are available—the Parallel Solistrand and the Ring Tongue Solistrand. Both eye and straight splices can be made with the parallel unit, example being installation of insulators as shown in the illustration. Flat tongue or tab of the ring-tongue connector has an accurately sized stud hole and provides a neat and secure means of attaching a wire end. Manufacturer: Aircraft-Marine Products Inc., 1580 North 4th St., Harris-



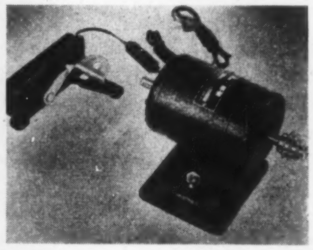
For further information circle MD 7 on card Page 289

Radial-Piston Hydraulic Pumps

Line of radial-piston hydraulic pumps supplying pressure to 3000 psi are rated from 1.25 to 185 gpm. Nonreversing types are available in six models with capacities from 1.25 to 30 gpm, operating speeds from 900 to 1800 rpm. Reversing-type pumps are made in four models with capacities from 23 to 185 gpm, operating at speeds from 720 to 900 rpm. Three types of control are available: Constant pressure setting with or without handwheel volume adjustment, automatic reduction of pump stroke at any desired point, and servo-reversing control which provides infinite control of pump discharge in both directions without changing direction of rotation of the pump. Manufacturer: Hydro-Power, Inc., Belmont & Sheridan Ave., Springfield, Ohio.

For further information circle MD 8 on card Page 289

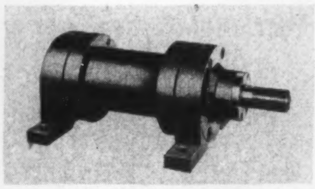
General-Purpose Motor



Universal electric motor designed for general-purpose application is rated at 1/10 hp, 5000 rpm when powered by either ac or dc current. The unit features a double-ended spindle ⅜-inch in diameter, and double-shielded, permanently-lubricated ball bearings. Measuring 3¼ inches in diameter, the motor is mounted on a pedestal and is supplied with three-step pulley, foot rheostat and reversing switch. Manufacturer: L & R Manufacturing Co., 577 Elm St., Arlington, N. J.

For further information circle MD 9 on card Page 289

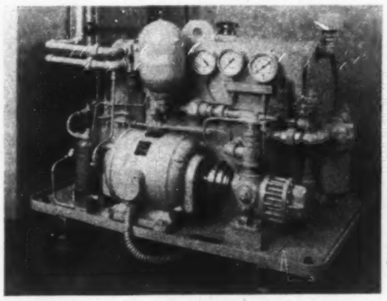
Hydraulic Cylinders



Redesigned line of oil hydraulic cylinders incorporates a number of outstanding features. Engineered for simplified installation, the cylinder ports may be easily repositioned to suit the application. This feature permits simplified piping. Heads are flame cut and machined from steel-mill plate, and caps, flanges, tubes, piston rods and C-rings are also steel. Pistons are aluminum alloy with step-seal piston rings for good sealing. Neoprene O-ring packings are used for gasketing and so installed that higher pressures result in tighter sealing, while C-ring construction eliminates necessity of tie rods and reduces installation space required. Units are designed to operate at 1500-psi working pressure. Manufacturer: Air and Hydraulic Div., Lindberg Engineering Co., 2444 W. Hubbard St., Chicago 12.

For further information circle MD 10 on card Page 289

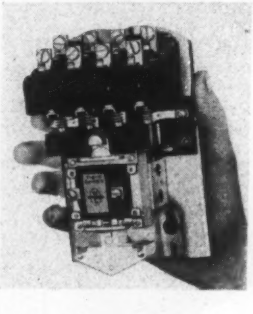
Hydraulic Power Unit



Dual-pump unit for supplying pressure in two stages is especially recommended for hydraulic press operation. High-volume, low-pressure pump providing up to 35 gpm builds pressure to a maximum of 350 psi. High-pressure pump then automatically takes over building up pressure to 2000-6000 psi as required by demand unit. Known as the Seco Power Package, the unit is powered by single through-shaft electric motor and has integral control valves, magnetic starter, oil reservoir and gages. Available styles vary in capacity from 2000 to 6000 psi, have maximum space requirements of 54 by 48 inches by 42 inches high. Manufacturer: Simplex Engineering Co., Zanesville, Ohio.

For further information circle MD 11 on card Page 289

Solenoid-Operated Contactors



Contactors for reversing or accelerating a-c motor controllers are recommended for use with such equipment as pumps, compressors, machine tools, etc. Bulletin 4451, size 1 solenoid contactors are equipped with double-break silver-to-silver contacts and are arranged on a steel mounting plate having recommended NEMA standard mounting dimensions. They have up to four main poles and have maximum rating of 7½ hp operating on 440-550 volt, 3-phase, 60-cycle power. Standard operating coils are available for 110, 220, 440, and 550-volt operation on frequencies of 25, 50 and 60-cycles. Outstanding features include complete accessibility of parts, compact construction, consistent operation and high arc-interrupting capacity. Manufacturer: Ward Leonard Electric Co., Mount Vernon, N. Y.

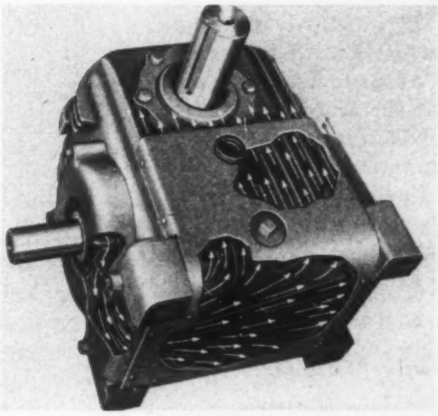
For further information circle MD 12 on card Page 289

Shaded-Pole Motors

Shaded two-pole, brushless type motor has gear train which provides a minimum speed of 1 rpm and maximum of 650 rpm. Motor, operated from 115, 60, 45 and 13-volt circuits, has sintered-bronze bearings and die-cast housing. The unit is suggested for use with such apparatus as coin-operated machines, animated displays, etc. It is manufactured by the Electric Motor Corp., Division of Howard Industries, Racine, Wis.

For further information circle MD 13 on card Page 289

Air-Cooled Speed Reducers

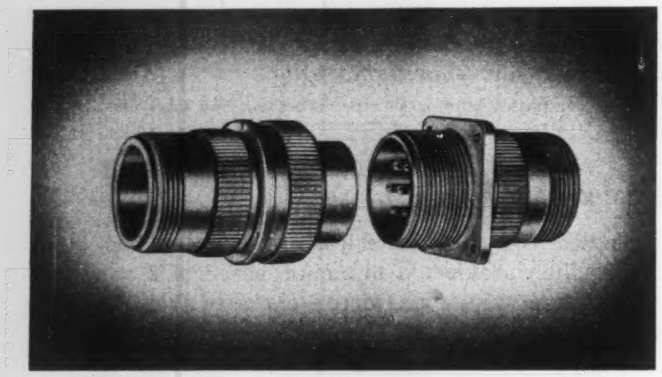


Cone-drive speed reducers of new line are air cooled, eliminating the necessity of taking thermal ratings into consideration in selection. Maximum mechanical-horsepower rating of the reducers is the only rating which need be considered. The fan-cooled reducers are available in ratings from 2.5 to 119 hp and in reductions from 5:1 to 50:1. They are recommended for smooth, high-power driving. Center distances range from 4 inches to 8 inches. Manufacturer: Cone-Drive Div., of Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12.

For further information circle MD 14 on card Page 289

Multiple Electrical Connectors

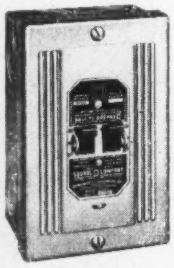
Water-tight multiple-conductor electrical connectors are said to be unaffected by vibration and shock because of exceptionally sturdy design. Applicable to installations where service requirements demand performance in the temperature range −67 F to +300 F, the connectors feature the use of a new high-quality dielectric known as Scinflex. Units have



an aluminum-alloy shell with Scinflex plastic inserts. Because of the plastics' flexibility, pin and socket can be made to interfere, excluding dirt and moisture. Connectors are made in wall-mounting, box-mounting and straight-plug assemblies carrying up to 30 conductors. They will carry current up to 200 amperes in the larger wire sizes. Manufacturer: Scintilla Magneto Div., Bendix Aviation Corp., Sidney, N. Y.

For further information circle MD 15 on card Page 289

Circuit Breakers

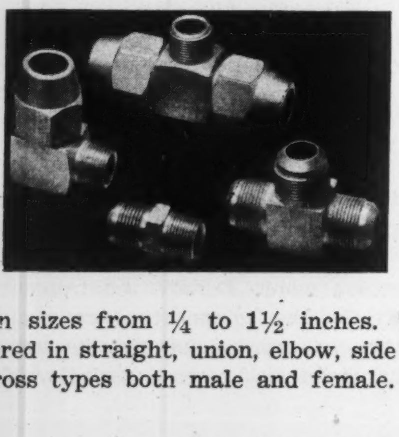


Thermal-magnetic type of circuit breakers, providing instant tripping on short circuits but holding on harmless overloads, function in 1/50 to 1/100-second. Known as the Multi-Breaker, new units are recommended for small motor circuits. They are furnished in 1947 NEC ratings of 15, 20 and 30 amperes, 120/240 volts ac, in either flush or surface mounts. Manufacturer: Switch and Panel Division, Square D Co., 6060 Rivard St., Detroit 11.

For further information circle MD 16 on card Page 289

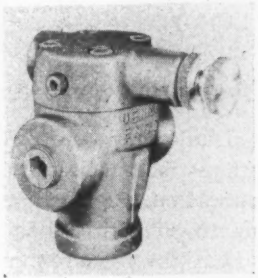
Heavy Tube Fittings

Heavy-duty tube fittings said to be 21 per cent heavier than usual fittings are available in complete line. Units are cadmium-plated steel and are manufactured in sizes from ¼ to 1½ inches. They are manufactured in straight, union, elbow, side tee, tube tee and cross types both male and female. Fittings are claimed to be of special value in heavy duty or high-pressure applications. Manufacturer: Flodar Corp., 331 Frankfort Ave., Cleveland.



For further information circle MD 17 on card Page 289

High-Pressure Relief and Sequence Valves



Rated at 5000 psi, line of ¾-inch valves is designed for relief, sequence and unloading. The units, which are available in either the threaded or flanged types, are said to be unusually fast in operation because of small differential between opening and closing pressures. Small size and sturdy construction make them adaptable to both large and small hydraulic systems. Provision has been made in the valves for remote control of pressure adjustment and pilot circuit or gage connection. Manufacturer: Denison Engineering Co., 1160 Dublin Rd., Columbus 16.

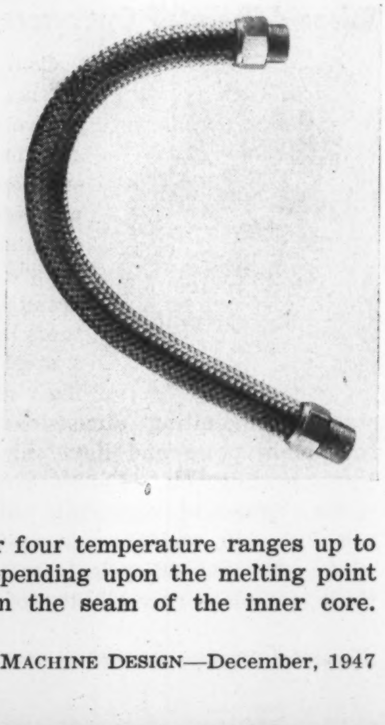
For further information circle MD 18 on card Page 289

Thermosetting Plastics

Tailor-made series of resins, known as Selectron, for use in laminating, casting, impregnating, molding and as adhesives are available in various property ranges. They may be designed to have various hardnesses, flexibilities, heat resistances, etc., to suit particular needs. Recommended applications include aircraft parts, automobile parts and electrical components. Manufacturer: Pittsburgh Plate Glass Co., Milwaukee.

For further information circle MD 19 on card Page 289

Flexible Monel Tubing

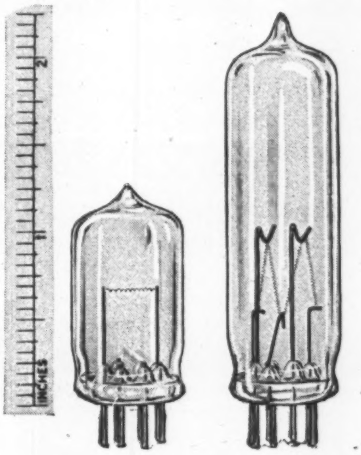


Recommended for those applications where corrosion-resisting requirements cannot be met by brass, or where the operating temperature is above 300 F, Titeflex Monel metal tubing resists the attack of acids, alkalies and salts over a wide range of concentration and exposure conditions. The tubing is supplied for four temperature ranges up to 1785 F, the range depending upon the melting point of the solder used in the seam of the inner core.

Tubing is supplied in the same sizes and with the same fittings as the standard Titeflex tubing and with either single or double bronze braid and brass fittings. Monel fittings are also available. Manufacturer: Titeflex, Inc., 532 Frelinghuysen Ave., Newark 5, N. J.

For further information circle MD 20 on card Page 289

Current-Regulator Tube



Miniature T5½ regulator tubes will control current from 60 amp to one amp with a maximum power dissipation of 3 watts in the larger size and 2 watts in the smaller size. Characteristic of tube is such that a 10 per cent current change will result in a 200 per cent voltage drop. Sturdily built, the regulator will withstand accelerations up to 25g, and is unaffected by temperature changes in the range −40 C to + 70 C. Hermetically sealed, it is unaffected by changes in pressure or humidity. Standard miniature octal socket is used for tube. Manufacturer: Amperite Co., 561 Broadway, New York 12.

For further information circle MD 21 on card Page 289

Corrosion-Resistant Centrifugal Pumps

Line of aluminum-bronze centrifugal pumps are designed for handling acids, salts, alkalies and other materials where corrosive elements are involved. The new units are single-stage, single-section, closed-impeller models having all liquid passages streamlined for high efficiency, quiet operation and minimum wear. Bearing thrusts are relieved by hydraulic balance. Complete series of pumps are available in two types, close coupled and pedestal, the later being useful for convenient connection to any type of drive. Models now available include: 1½ by 1¼ in., 2 by 1½ in., and 2½ by 2 in. Capacities of the units range up to 240 gpm with delivery heads to 170 ft. Manufacturer: Ampco Metal, Inc., 1745 S. 38th St., Milwaukee 4.

For further information circle MD 22 on card Page 289

Colored Finish for Aluminum

Die-castings of aluminum may be anodized in colors by the use of new process. Colors produced are said to be lustrous and bright but not as vivid as those produced on wrought aluminum by conventional anodizing and dyeing processes. Wide range of colors is possible including red, blue, green, yellow, black, and gray. Casting thus coated also has benefit of corrosion protection, passing 250-hour salt spray test, and has enhanced abrasion resistance. Manufacturer: Technical Processes Div., Colonial Alloys Co., Ridge Ave. and Crawford St., Philadelphia 29.

For further information circle MD 23 on card Page 289

Flexible Metal Hose

Fire-proof flexible metal hose in two types is recommended for use as fuel, oil, instrument and vacuum lines. Type CMH-FP-2-41 has been approved by the CAA as fire proof, while CMH-FR-51 has been approved as fire resistant. Both forms of tubing are available in sizes ranging from ⅜ to 1½-inch inside diameter. The hose has passed the rigid CAA test in which oil at 200 F and 30 psi is circulated through the hose while it is bent at 90 degrees and vibrated at 2000 cycles per minute. During this test flame at 2000 F is directed at the hose for five minutes. Manufacturer: Chicago Metal Hose Corp., Maywood, Illinois.

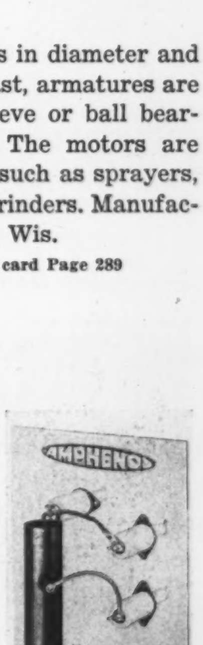
For further information circle MD 24 on card Page 289

Fractional-Horsepower Motor

Newest addition to the Oster line of electric motors is the type DU-400 universal series. Units have standard ratings of 1/30-hp at 7500 rpm and are designed for continuous duty on 115 volts. They will operate on both ac and dc with varying speed characteristics. The motors weigh 2 pounds are 2½ inches in diameter and are 4 inches long. Housings are die cast, armatures are dynamically balanced and either sleeve or ball bearings are available to specification. The motors are recommended for portable machines such as sprayers, engraving machines, projectors and grinders. Manufacturer: John Oster Mfg. Co., Racine, Wis.

For further information circle MD 25 on card Page 289

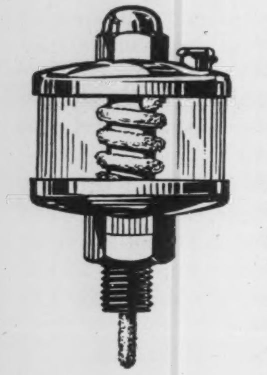
Ceramic Tube Sockets



Steatite sockets for metal industrial electronic tubes permit mounting on noninsulated surfaces. Available in 3/16 or 1/4-inch sizes, the sockets can be used to support the tube and also to serve as tie points or feed-through insulators for tube-element connections. Surface electrical-creepage distances are held at about 2 inches, enabling use of high voltages; exterior of stand-off is glazed and metal parts are plated. Units are available either with or without feed-through bushings for back-of-panel wiring. Manufacturer: American Phenolic Corp., 1830 S. 54th Ave., Chicago 50.

For further information circle MD 26 on card Page 289

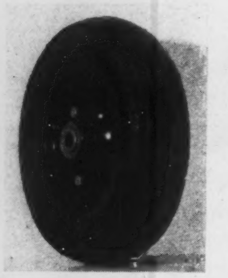
Wick-Type Oil Feeder



Unbreakable wick-type oil feeder has brass body supporting Lucite reservoir. Oil in the reservoir is carried through the wick over a standpipe to the bearing. No adjustment is required other than periodic filling of unit. Providing a simple positive means of lubrication and at the same time filtering dirt and sediment from the oil, the feeder also indicates at a glance when refilling is necessary, thus safeguarding against empty oilers. Manufacturer: Oil-Rite Corp., 3476 S. 13th St., Milwaukee 7.

For further information circle MD 27 on card Page 289

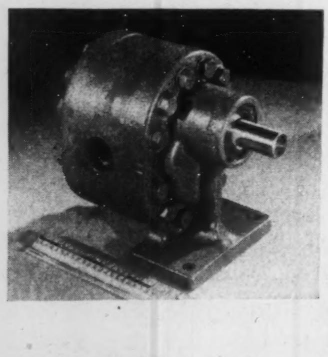
Rubber-Tired Wheels



Line of rubber-tired steel wheels, 4, 6, 8, 10 and 16 inches in diameter feature swedged one-piece bushing holding wheel-disks together, preventing collapse. Bushings are permanently swedged and guaranteed not to loosen and turn. Semipneumatic tires are available with 6 and 8-inch wheels, solid tires with 4 and 6-inch sizes. Heavy-duty wheels with flat, solid-rubber tires and ball-bearing axles are available in the 8-inch diameter model. Manufacturer: Circle Metal Mfg. Co., 4300 E. Pacific Way, Los Angeles 23.

For further information circle MD 28 on card Page 289

Reversible Gear Pump



Reversible, Hydraulic gear-pump series, known as the Cub line, is available in 10, 15, and 20 gpm capacities. Having an overall efficiency rating of 90-92 per cent, the units are recommended for hydraulic-power applications on such machines as farm equipment, machine tools, construction and materials-handling equipment. Floating bronze wear plates at either side of the gear divide clearance into four extremely narrow slits, thus providing high frictional resistance to flow recirculation. A small built-in valve directs slippage oil past the shaft needle bearings for positive, continuous lubrication. Rotary shaft seal guarantees long service life without need of frequent attention. Manufacturer: Hydro-Power Inc., Springfield, Ohio.

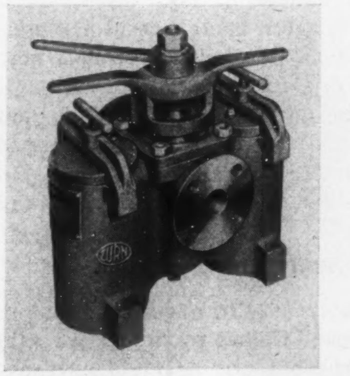
For further information circle MD 29 on card Page 289

Air Compressors

Line of two-stage, air-cooled stationary air compressors is available in nine sizes with power requirements ranging from 15 to 100 hp, and displacements ranging from 81 to 590 cfm at 100 psi. The three standard electric drives of the Unitair compressors include built-in motor, direct-connected motor and V-belt drive; models may also be equipped for use with gasoline or diesel engines. Features of the new line include: Force-feed lubrication, cascade cooling, low-lift valves, low piston speeds and over-sized bearings. Manufacturer: Sullivan Div., Joy Manufacturing Co., Oliver Building, Pittsburgh 22.

For further information circle MD 30 on card Page 289

Twin Sediment Strainer

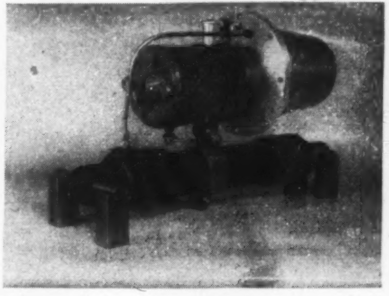


Designed to meet the demand for an economical strainer in pipe lines where continuous flow is imperative, new duplex strainer permits flow to be diverted from one basket to the other without interrupting passage through the strainer. Unit operates by means of a single plug-type valve directing flow from the inlet to either basket or both simultaneously. Seating of the plug into the body is regulated by a relieving yoke which acts to seat the plug tightly for sealing or to loosen it for turning. Dual air-relief valves are furnished with either flanged or screwed connections and are suitable for working pressures from 125 to 300 psi. Basket-chamber cover-yoke assembly or C-washer type bolted cover assembly is furnished as required. Both types are quick releasing. Made of bronze, steel, semisteel or special alloys to specification, the strainer is available in standard sizes from one to six inches. Larger sizes are available to order. Manufacturer: J. A. Zurn Mfg. Co., Erie, Pa.

For further information circle MD 31 on card Page 289

Hydraulic Pumping Unit

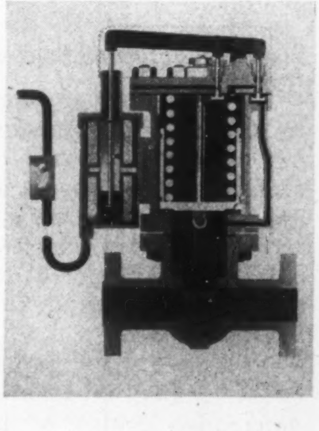
Low-cost hydraulic pumping unit is designed especially to actuate cylinders. Pump, which measures 14 inches long and 7½ inches in diameter, is powered by a six-volt motor and generates 1000 psi with a maximum displacement of 46 cubic inches of fluid. It is supplied with motor, reservoir, check valve, release valve and adjustable relief valve. Unit may be operated in either horizontal or vertical positions. Available modifications include large-capacity reservoir, externally-mounted four-way valve for double-acting cylinders and 115-volt ac motor. Manufacturer: John Dusenbury Co., 150 Pine St., Montclair, New Jersey.



For further information circle MD 32 on card Page 289

High Pressure Control Valve

Flow-control valve for use in fluid systems with pressures up to 6000 psi is available in sizes from one inch upward. Controlled by dual solenoids, the valve is powered by line pressure introduced behind a large driving piston. Unit is thus opened by line pressure, closed by a powerful spring. No control power is required to maintain either position. Modifications include pneumatic or hydraulic control, manual operation being possible at all times with any one of the systems. Control system is applicable to gate, globe, angle and many other types of valves. Manufacturer: Shafer Valve Co. Inc., Mansfield, Ohio.



For further information circle MD 33 on card Page 289

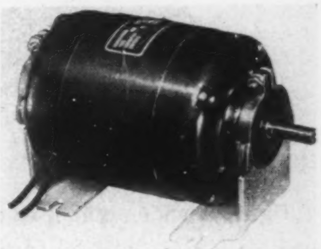
Multiple Oiler

Centralized lubrication system for continuously oiling remote bearings, consists of a supply reservoir feeding copper tubes leading to remote oiling points, and transparent constant-level reservoir feeding supply, reservoir. By use of dual reservoir system, oil level in supply reservoir is kept at a constant level providing an even lubricating pressure. Well-regulated supply is thus assured, and overflow and flooding of bearings rendered impossible. Feature of system is inclusion of individual valves in supply lines, permitting the flow to each bearing to be adjusted individually or turned completely on or off. Manufacturer: Gits Bros. Mfg. Co., 1846 S. Kilbourn Ave., Chicago 2.

For further information circle MD 34 on card Page 289

Split-Phase Electric Motor

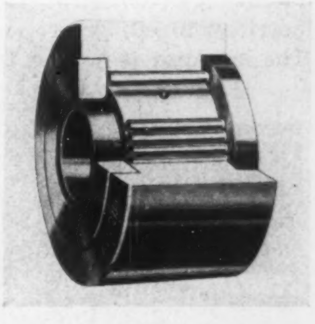
Designed for application to office machines, coin-operated devices, circulating pumps and other units requiring fractional-horsepower drives, type U motor is available in three ratings. For operation at 1725 rpm, 1/20 and 1/15-horsepower models are manufactured, while a 1/30-horsepower motor is made for operation at 1125 rpm. Features of the unit include large oil reservoirs around sleeve bearings, resilient mounting rings, thermal overload protection and quiet operation. Manufacturer: Bodine Electric Co., 2264 W. Ohio St., Chicago.



For further information circle MD 35 on card Page 289

Cam-Follower Bearing

Cam-yoke roller bearing is the latest addition to the McGill Multirol full-type roller-bearing line. Built with an inner race to increase adaptability where mounting by the conventional cam-follower stud is undesirable, units are available in sizes ranging from 0.250-inch to 1.25 inches. Internal construction of the cam-yoke bearing is similar to the Multirol cam follower, having an extra-heavy outer race section and a full complement

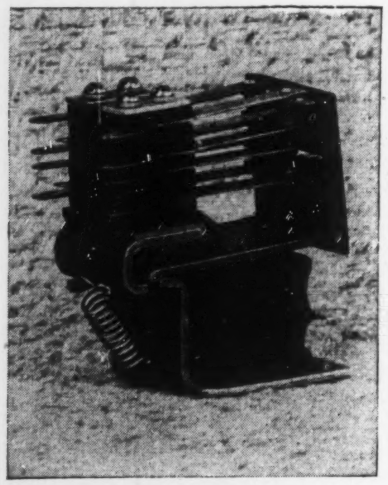


of small rounded-end rollers. Their full usable length provides maximum load-carrying capacity. Manufacturer: McGill Mfg. Co. Inc., Valparaiso, Indiana.

For further information circle MD 36 on card Page 289

Appliance Relay

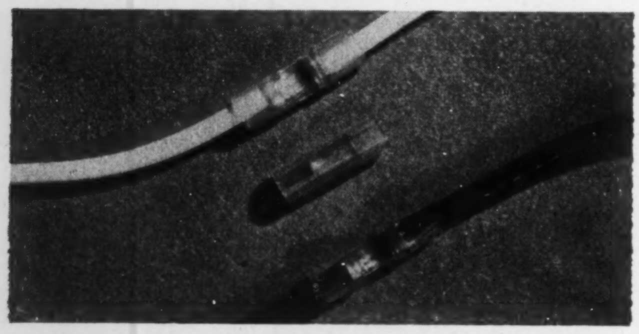
Multicontact a-c relay designed specifically for appliances and vending machines is available in ratings of 5 amp, 115 volts ac, or 5 amp, 24 volts ac. The new two-circuit relay occupies only three cubic inches, and has large rocker bearing and generous contact pressure to minimize the effects of dust and fatigue. A wide number of relay forms can be obtained through combinations of contacts. The relay may be mounted conveniently by any two of the four tapped holes in its base and soldered connections are readily made to the coil and contact terminals. Manufacturer: General Electric Co., Control Division, Schenectady, N. Y.



For further information circle MD 37 on card Page 289

Electric Wire Connectors

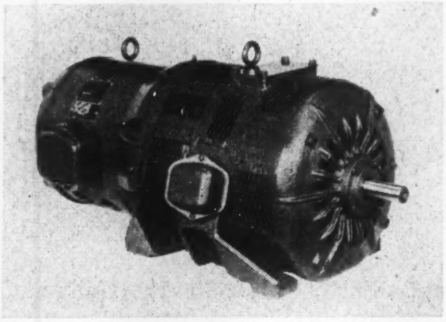
Pressure-type wire-connector line known as the Sta-Kon now includes the No. 25 insulated splice. New connector is seamless bronze protected by a translucent, high-dielectric plastics insulator that is impervious to oil, grease, water, chemicals and acids. The insulator is bonded to the connector and cannot slip or become accidentally detached. Splice is unique in that a single squeeze of the installing tool permanently connects wires and insulates the connection. The No. 25 splice will accommodate two No. 16 wires, one No. 14 and one No. 20, and various other combinations of sizes. Manufacturer: Thomas & Betts Co. Inc., 36 Butler St., Elizabeth 1, N. J.



For further information circle MD 38 on card Page 289

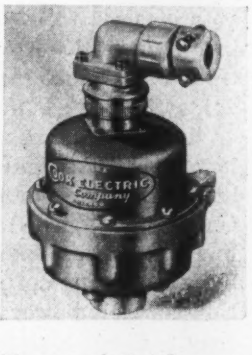
Variable-Speed A-C Drive

Device for transmitting controlled torque through the use of electro-magnetic forces is especially suited for driving such equipment as printing presses, slitters, and other variable-speed machines which require a constant-torque throughout their operating range. The Adjusto-Spede a-c motor is a single-unit drive operating direct from a 2 or 3-phase a-c supply. No additional motor generator or exciter is involved. Full rated torque throughout operating-speed range and intermittent full-rated torque at speeds below operating range are produced. Consisting essentially of a conventional squirrel-cage motor combined with an eddy-current clutch, the machine is of unit construction for ratings to 75 hp. Larger machines incorporate separately mounted and coupled motor and clutch. Manufacturer: The Louis Allis Co., Milwaukee 7.



For further information circle MD 39 on card Page 289

Pressure-Actuated Switch



For use with pressures to 2000 psi, the Hi-Pressure switch is designed for the control of high-pressure hydraulic, air and steam systems. Unit is available in models to suit any one of four different pressure ranges, 5 to 50 psi, 50 to 200 psi, 200 to 500 psi, and 500 to 2000 psi. Pressure differential between on and off positions is approximately 10 per cent of operating pressure. The two-pound unit is housed in an aluminum casting having threaded pressure con-

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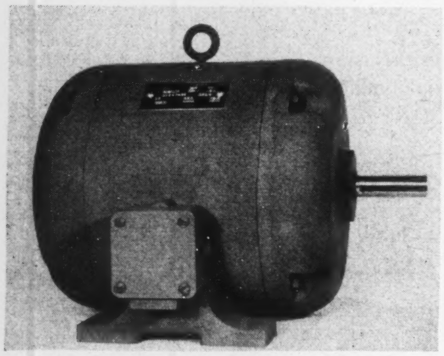
nections ranging in size from ⅛ to ¾-inch standard female pipe thread. The electrical contacts of the single-pole double-throw type are capable of handling 10 amperes at 115 volts ac. Typical applications are aircraft hydraulic installations, fuel systems and warning apparatus on presses and boilers. Manufacturer: Diaphlex Div., Cook Electric Co., 2700 Southport Ave., Chicago 14.

For further information circle MD 40 on card Page 289

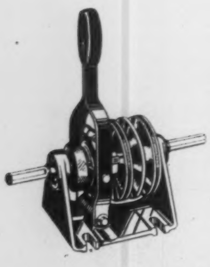
Totally-Enclosed Motors

Three-phase, totally-enclosed motors are available in a new line including 1½, 2 and 3-hp units. Motors feature a squirrel-cage rotor which uses rolled sheet-copper bars. Use of sheet copper is said to guarantee uniformity and low internal rotor resistance. Thoroughly tested, average 1½-hp motor, for example, is rated at 1160 rpm and draws 2.6 amps on 440-volt, 60-cycle power. Torque produced is 6.9 lb-ft. Rotor is equipped with grease-sealed cartridge-type bearings and stator windings are carefully impregnated with a high-quality baking varnish. The motors have a special cast-iron outlet box threaded for proper size of conduit. Holes in mounting feet are spaced in accordance with NEMA specifications. Manufacturer: Kato Engineering Co., Mankato, Minn.



For further information circle MD 41 on card Page 289

Packaged Clutch Assembly

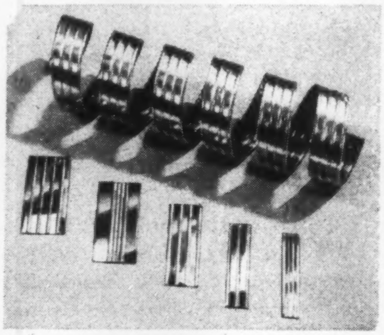


Packaged clutch complete with pulleys and mounting bracket is rated at 10 hp. Having heavy-duty bearings throughout, the unit may be operated at speeds up to 3600 rpm. Rated capacity is 315 lb-in., or ½-hp per 100 rpm. The clutch can be either direct connected or V-belt driven. If direct connected to a power source, both the extension shaft and the double-groove pulley can be used to drive separate accessories. If the clutch is belt driven from a power source, the two extension shafts can be used to drive accessories. Manufacturer: Marine Products Co., 515 Lycaste Ave., Detroit.

For further information circle MD 42 on card Page 289

Preplated Metal Pattern

Available in coils of steel-base metals up to 0.015-in. gage, and in zinc-base metals up to 0.018-in. gage, Nickeloid preplated metals are now made in the pattern Crimp Metal. New pattern consists of round embossing, either raised or depressed on the polished side of the metal, running the length of the coil. Embossing makes an interesting design and increases the rigidity of the metal. Being bright preplated, the material reaches the user in coils which require no buffing or polishing. It is recommended for trim or structural use. Manufacturer: American Nickeloid Co., Peru, Illinois.

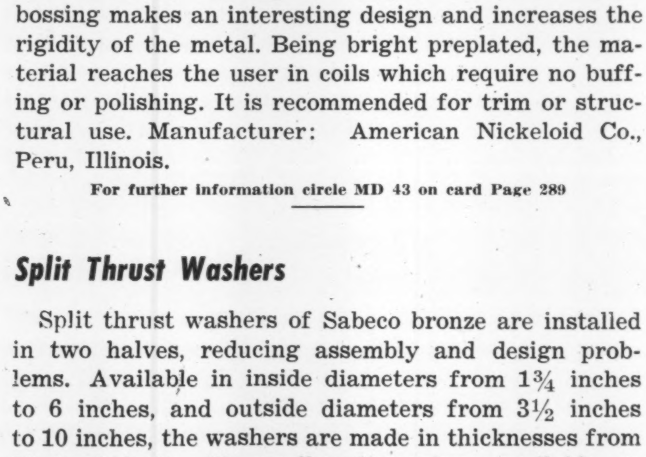


For further information circle MD 43 on card Page 289

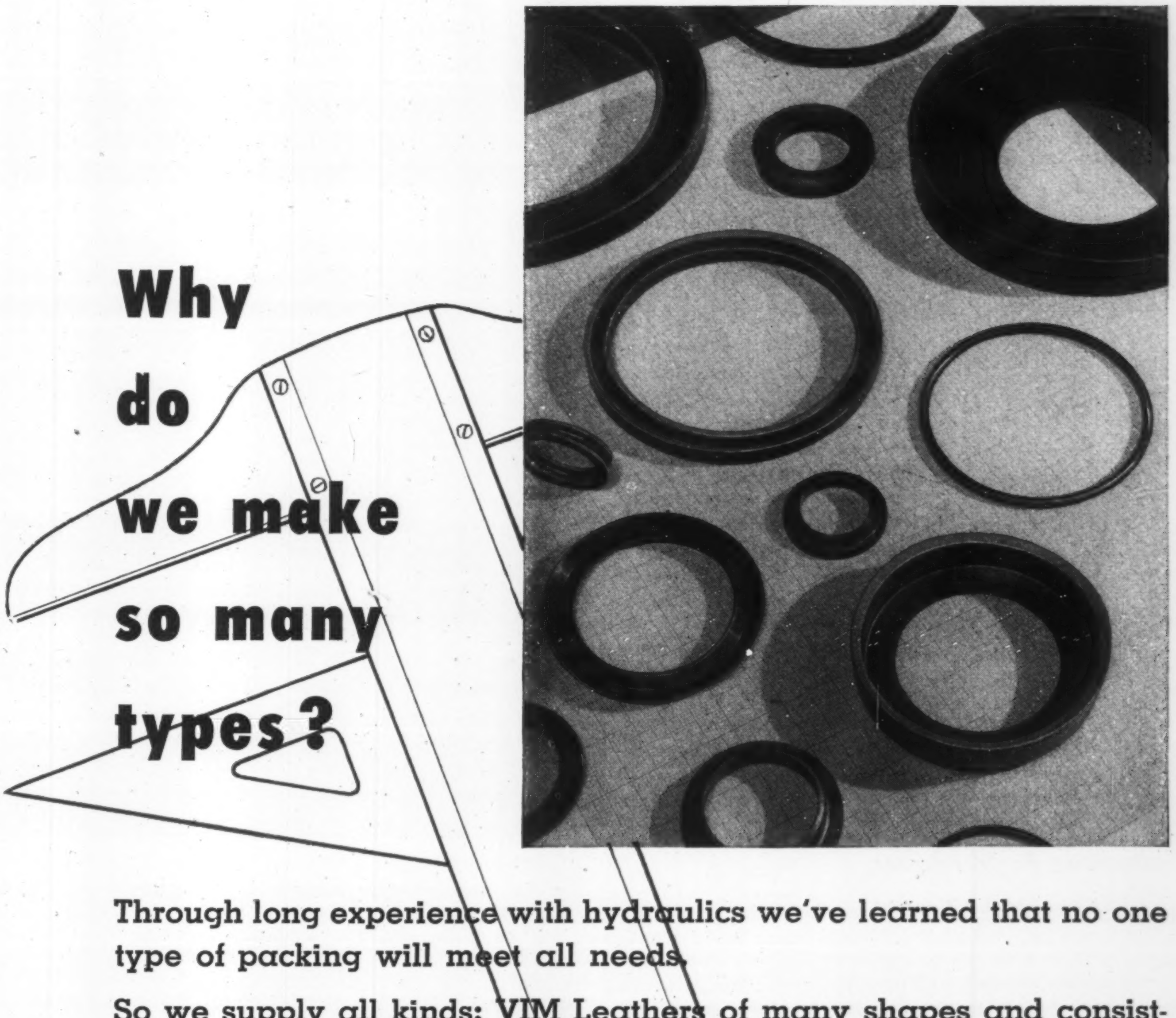
Split Thrust Washers

Split thrust washers of Sabeco bronze are installed in two halves, reducing assembly and design problems. Available in inside diameters from 1¾ inches to 6 inches, and outside diameters from 3½ inches to 10 inches, the washers are made in thicknesses from ¼ to 1 inch with smaller dimensions available on special order. Oil grooves and oil holes may be provided to specification. Units are recommended for applications where great thrust loads must be provided for. Manufacturer: Saginaw Bearing Co., 821 S. Water St., Saginaw, Mich.

For further information circle MD 44 on card Page 289



Why do we make so many types?



Through long experience with hydraulics we've learned that no one type of packing will meet all needs.

So we supply all kinds: VIM Leathers of many shapes and consistencies, VIX-SYN fabricated and homogeneous synthetic rubber packings, and the popular "O" rings.

This complete line enables us to make unbiased recommendations based on pressures, temperatures, media and service conditions.

Add to this the engineering design aid for which Houghton is famous, and you have a source for packings and packing service which can prove most helpful. We invite you to use it.

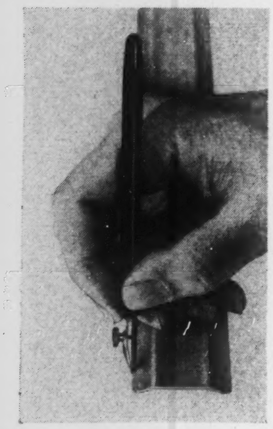
E. F. Houghton & Co., 303 West Lehigh Avenue, Philadelphia 33, Pa.
Service and sales in all principal cities.

HOUGHTON'S
VIM LEATHER & VIX-SYN
PACKINGS

engineering dept equipment

To obtain additional information on these new developments see Page 289

Ruling Pen with Plastics Handle

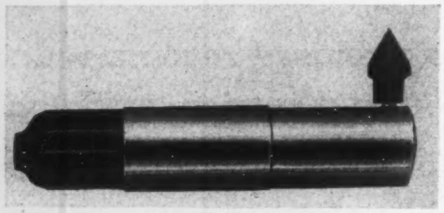


Balanced ruling pen has handle extending close to tip of pen making possible short grip without grasping blades. The Microliner pen has form-fitting plastics handle, and blades machined from solid, octagonal, surgical steel with hand-finished nibs. Highly polished blades provide excellent flow of ink to facilitate ruling fine lines. Holding generous supply of ink, pen is suitable for heavy as well as fine ruling. Manufacturer: V. & E. Mfg. Co., 758 S. Fair Oaks Ave., Pasadena 20, Calif.

For further information circle MD 45 on card Page 289

Tachometer Angle Adapter

Permitting speed measurement in cramped quarters where the clearance at the end of the rotating shaft is as little as two inches, the type 45 angle adapters are available for use with Metron hand tachometers. The adapter slips readily over the standard head. It is precision built and consists of a pair of miter gears supported by permanently-lubricated ball bearings. Tachometer carrying case has space provided for this adapter along with the tachometer itself. Manufacturer: Metron Instrument Co., 432 Lincoln St., Denver 9.



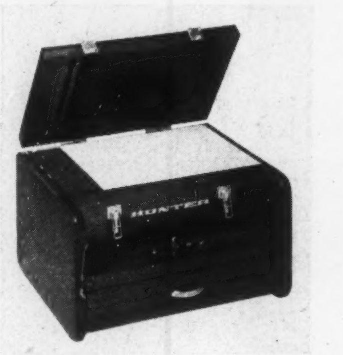
For further information circle MD 46 on card Page 289

Transparent-Edge T-Square

Entirely constructed of plastics, Regal line of T-squares is available in sizes from 18 to 60-inches long. The straight-edges have blades of tan-finish plastics edged with a transparent material. Fixed-type head of black laminated plastics is securely fastened to blade by means of four hardened and plated steel drive pins. Square is designed for sturdy construction and low cost. Manufacturer: Engineering Mfg. Co., Sheboygan, Wis.

For further information circle MD 47 on card Page 289

Photocopying Machine



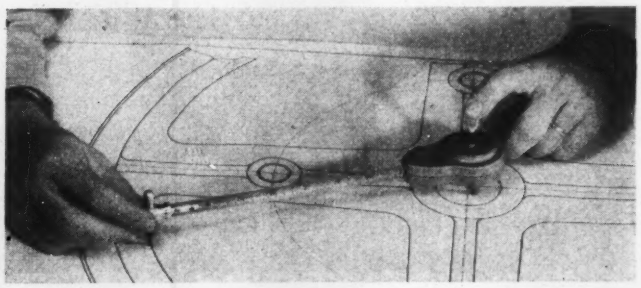
Model 1620 Electro-Copyist is a photocopying machine with a reproduction area measuring 16 by 20 inches. The machine measures 26 inches long, 22 inches wide and 16 inches high. It is equipped with timer, dual lights and red scanner light. Typical uses include reproduction of drawings, specification sheets and departmental memoranda. Manufacturer: Hunter Electro-Copyist, Inc., 566 Spencer St., Syracuse 4, N. Y.

For further information circle MD 48 on card Page 289

Beam-Type Compass

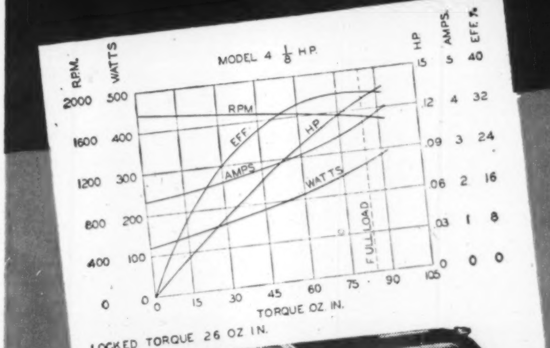
Omicron beam compass is an instrument for drawing circles as large as 144 inches in diameter. The device uses a flexible-rigid type of steel tape for a beam and the beam retracts into a die-cast case that will fit within the palm of the hand. Brake lever firmly locks the tape in any desired position and tape may be moved only when lever is depressed. Thus, rapid radius settings may be selected. Scribing head of instrument will hold standard drafting lead or a drafting pencil. Manufacturer: The Omicron Co., 532 W. Windsor Rd., Glendale 4, Calif.

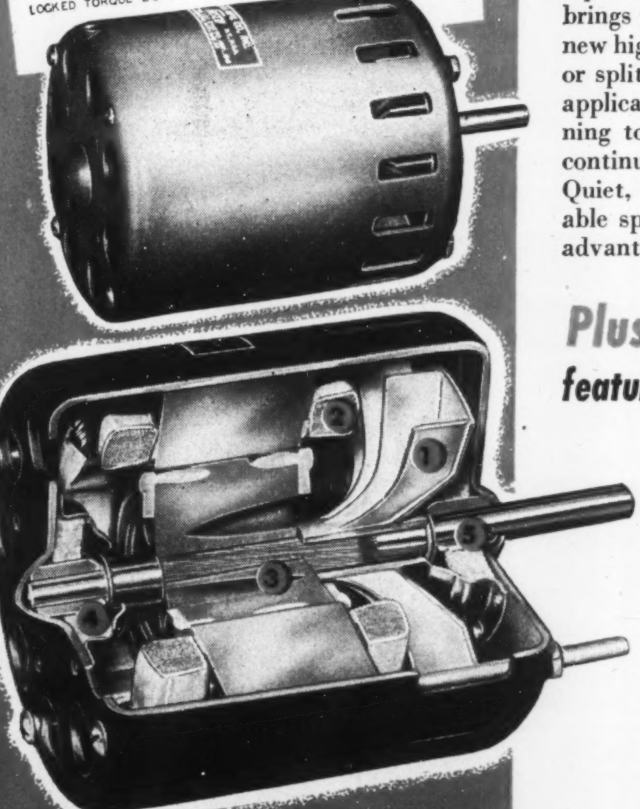
For further information circle MD 49 on card Page 289



NEW! FASCO SERIES R

SHADED POLE FRACTIONAL H.P. MOTOR DELIVERS 1/8 HORSEPOWER!





Now you can have the proved economy of a shaded pole motor in a new high power range

Here is a *new, exclusive* package of potential product design and sales advantages for you . . . all wrapped up in the new Fasco F.H.P. Motor Series R. Fasco *experienced* engineering and production know-how brings you in this Fasco shaded pole F.H.P. motor new high power, available before only in a capacitor or split-phase type motor at higher cost. Ideal for applications where starting torque is low and running torque requires up to 1/8 H.P. Designed for continuous operation under long hour duty load. Quiet, economical, trouble-free operation, dependable speed control and other Fasco F.H.P. motor advantages are incorporated.

Plus FASCO-built quality features for better performance

① INTEGRAL COOLING FAN, of new design and large vent holes.

② TAPELESS COILS, for improved heat dissipation.

③ UNIFORM ROTOR RESISTANCE and BALANCE from new pressure assembly and automatic machine welding.

④ LUBRICATED from large felt-filled reservoirs and a new oxidation-resistant oil.

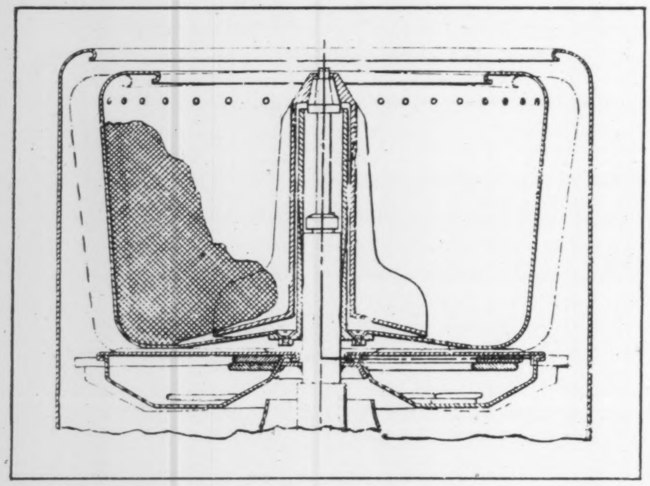
⑤ BEARINGS are precision oil-less, self-aligning type.

WRITE *on your company letterhead for complete information including dimensions, specifications and performance data. No obligation.*

A PRODUCT OF **FASCO**
F. A. SMITH MANUFACTURING CO., INC.
550 DAVIS ST. • ROCHESTER 2, N. Y.
FORMERLY **Pilot** MOTORS

Noteworthy Patents

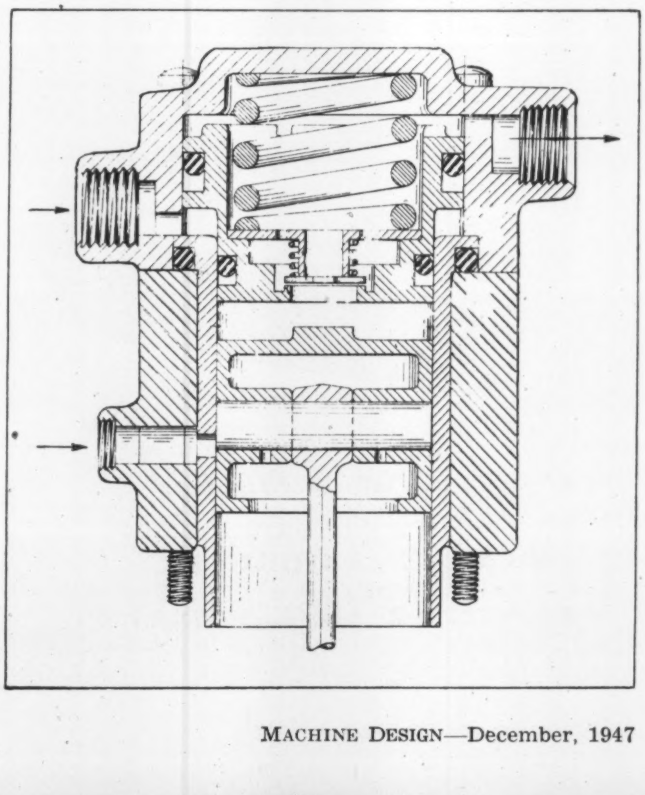
AUTOMATIC DYNAMIC BALANCING is obtained with an arrangement shown in patent 2,420,592 designed specially for vertical shaft high-speed centrifugal extractors such as those used in domestic or commercial laundering machines. Two or more annular weight rings are mounted around the axis of rotation, free to move within a housing which insures self-centering of the weights relative to the axis when the machine is at rest. Construction of the ring housing causes the rings, under influence of an out-of-balance condition during operation, to move in a direction horizontally outward and upward to a compensating position of adjustment with respect to the load unbalance so that the machine spindle rotates on a substantially true vertical axis. While more rings can be used, two usually serve to compensate satisfactorily for practically all unbalance conditions normally encountered in simple machines. Patent assigned to Electric Household Utilities Corp. by Andrew W. Gearhardt.



RAPID, SIMPLE MODIFICATION of the cam track for sequence controllers used in automatic machines is provided by a replaceable cam design covered in patent 2,418,757. Control of operational sequence in complex machine cycles, such as in pressure die casting, is made a relatively easy matter. Changes in rise, drop, angle, duration of time intervals, etc., of the cam or cams are effected by merely removing the proper cam segment and snapping in another. Patent assigned to The Sinclair-Collins Valve Co. by John E. Collins.

PROPORTIONING VALVE structure of patent 2,415,994 delivers preset temperature fluid by means of a bimetallic pressure control over one of the two mediums being mixed. A needle valve, controlled by the bimetal element which in turn is controlled by the temperature of the mixed fluid, feeds or cuts off pressure to a spring-loaded diaphragm to proportion the fluid from the inflows according to the preset value. Patent assigned to Curtis Automotive Devices by R. R. Curtis.

SENSITIVE CONTROL of final pressure developed by a multistage compressor of the high-speed type is provided by the design covered in patent 2,423,677. Assigned to the Weatherhead Co. by Roy O. Balogh, the device consists principally of movable cylinder heads each of which is automatically positioned by the final or reservoir pressure to provide a clearance volume of such magnitude that the system pressure remains constant. Simple in design, the device is light in weight and free of maintenance problems.



WHY ARE ZINC DIE CASTINGS THE MOST WIDELY USED?

The die casting process offers the least expensive method of making a very large variety of complex metal parts. Alloys based on several different metals are employed for die castings, but zinc has for many years been the most widely used. The answer is simple—the *zinc alloys provide the greatest number of desirable mechanical properties and casting characteristics at the lowest cost.* Future advertisements will discuss these advantages individually, to give you a better understanding of just what zinc die castings can do for you.

THE ANSWER IS HERE

SELECTION FACTORS		ZINC ALLOYS	ALUMINUM ALLOYS	MAGNESIUM ALLOYS
MECHANICAL PROPERTIES	Tensile Strength	1 (strongest)	2	3
	Impact Strength	1 (toughest)	2	2
	Elongation	1 (most ductile)	2	2
	Dimensional Stability	2	(1 most stable)	2
	Resistance to Cold Flow	2	1	1
	Brinell Hardness	1 (hardest)	2	2
PHYSICAL CONSTANTS	Electrical Conductivity	2	1 (highest)	3
	Thermal Conductivity	2	1 (highest)	3
	Melting Point‖	1 (lowest)	2	2
	Weight, per cu. in.	3	2	1 (lightest)
CASTING CHARACTERISTICS	Ease, Speed of Casting	1 (easiest)	2	2
	Maximum Feasible Size	1 (greatest)	2	3
	Complexity of Shape	1 (most complex)	2	3
	Dimensional Accuracy	1 (most accurate)	2	2
	Minimum Section Thickness	1 (thinnest)	2	2
	Surface Smoothness	1 (smoothest)	2	2
COST	Die Cost†	1 (lowest)	2	2
	Production Cost	1 (lowest)	2	2
	Machining Cost	1	2	1
	Finishing Cost‡	1 (lowest)	2	2
	Cost per Piece§	1 (lowest)	2	2
EXTENT OF USE		1 (most used)	2	3

‖ A low melting point is favorable in reducing die cost and upkeep and facilitates casting.
† Dies for casting the low melting point alloys are least expensive and have longest life.
‡ Includes polishing and buffing expense as well as ease of applying all types of commercial finishes, both electrodeposited and organic.
§ Based on die and fuel costs, production speed and machining and finishing costs.

Ask your die casting source for our booklets covering all phases of the die casting process—properties, design, machining, finishing—or write directly to us.

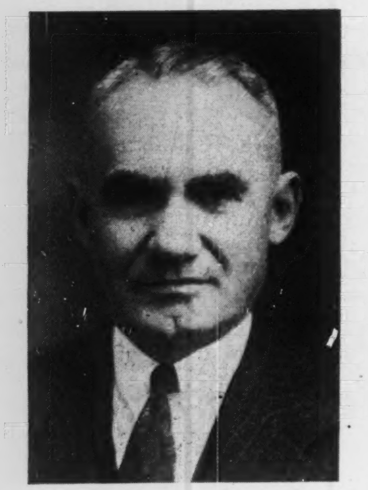
You probably know the zinc die casting alloys by the trade name, Zamak. The New Jersey Zinc Company developed alloys of specific compositions for the die casting industry and gave them this name. Zinc alloys of these compositions are the only ones used for die casting. Your die caster exercises careful control in the formulation of these alloys to assure maximum mechanical properties and dimensional stability.

ZINC
FOR DIE CASTING ALLOYS

THE NEW JERSEY ZINC COMPANY, 160 Front St., New York 7, N.Y.

The Research was done, the Alloys were developed, and most Die Castings are based on
HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

MEN...of...machines



H. A. Gehres

Ralph L. Boyer

H. A. GEHRES who with RALPH L. BOYER have been directing the engineering division of The Cooper-Bessemer Corp., which has come forward with a number of major developments in the engine and compressor-building field, have obtained recognition of their outstanding record. Mr. Gehres has been named executive vice president and Mr. Boyer's new title is vice president and chief engineer. Joining the company in 1910 when it was known as the C. & G. Cooper Co.—three years after his graduation from Ohio State University with a mechanical engineering degree—Mr. Gehres subsequently became chief engineer in 1920. He served in that capacity until 1935 (In 1927 he was made director of the company) when he became vice president and director of engineering. He remained in this position until his present promotion as executive vice president.

Mr. Boyer prior to his recent appointment as vice president and chief engineer was chief engineer since 1938. He had been made assistant chief engineer in 1929. Before joining Cooper-Bessemer in 1926 as diesel engineer, he served in the same capacity with the Sperry Gyroscope Co. Mr. Boyer was graduated from Ohio State University with a mechanical engineering degree in 1924, and received his master's degree in 1930.

Both Mr. Gehres and Mr. Boyer have achieved positions of leadership in the diesel, gas engine and compressor fields during their long association with the Cooper-Bessemer organization, and have aided in the constant growth of the company.

Henry W. Kayser

HENRY W. KAYSER, associated with The Falk Corp. as designer, application engineer and development engineer since 1938, has been promoted to supervisor of development engineering for the company. Previous to his becoming associated with the Falk organization he had served in the engineering department of Fisk Rubber Co. Born in Iowa, Mr. Kayser received his degree from the Engineering School of Marquette University in 1931. Later he took advanced work in strength of materials at the University of Wisconsin. During the past few years at Falk, he has played a large part in the analysis and development of new products and, in his present new post, will continue in this work in a supervisory capacity. Also he will be available for consultation in the field when his services are needed.

EARLE S. MacPHERSON—as executive engineer on all Ford, Lincoln and Mercury products — will be in a position to utilize his broad experience in all phases of automobile engineering. Prior to joining the Ford engineering staff, Mr. MacPherson was associated with General Motors. Upon graduation in

Earle S. MacPherson

"AMERICA'S MOST MODERN SCREW"

Sparkplug of the Assembly Line

CLUTCH HEAD *HURDLES ALL THE "FUMBLE SPOTS"* that retard speed and break the smoothness of operation through every phase of assembly...the logical result of these exclusive advantages combined in both screw and bit:

No Slow-down Hesitation	• • •	***The Clutch Recess Presents a Bold Target***
Deep Dead-Center Entry	• • •	***Makes Straight Driving Automatic***
No Driver Canting	• • •	***No Burred or "Chewed-up" Heads***
Non-Tapered Driving	• • •	***CLUTCH HEAD'S Engagement is All-square***
No "Ride-out" to Combat	• • •	***Rules Out the Skid Hazard***
No Exhausting End Pressure	• • •	***Disposes of a Fatigue Factor***
Easy One-handed Reaching	• • •	***Solved by the CLUTCH HEAD Lock-On***
The Extra Rugged Type "A" Bit	• • •	***Drives up to 214,000 Screws, Non-stop***
Repeated Bit Reconditioning	• • •	***A 60-Second, On-the-spot Operation***
Common Screwdriver Operation	• • •	***Exclusively a CLUTCH HEAD Feature***

Check these "fumble-spots" on your line and figure what their elimination would mean in terms of faster, safer, and lower cost production. CLUTCH HEAD *users have found output stepped up as much as 50%.*

CLUTCH HEAD SCREWS

You may examine and test the special features provided ONLY *by "America's Most Modern Screw"...right at your desk. Send for package assortment of screws, sample Type "A" Bit, and illustrated Brochure.*

UNITED SCREW AND BOLT CORPORATION

CLEVELAND 2 CHICAGO 8 NEW YORK 7

1915 with a mechanical engineering degree from the University of Illinois, he secured a position in the Chalmers Motor Co. laboratory. Two years later when he was head of the department, he left Chalmers to serve on the Bolling Commission as a civilian engineer. During the first World War he was placed in command of the engine division, aviation technical section, A.E.F. After twenty-six months overseas, he returned to a position as assistant chief engineer for the Liberty Motor Car Corp. where he remained until 1922 when he joined the Hupmobile Corp. From 1930 to 1934 he was assistant chief engineer. Mr. MacPherson then joined General Motors as assistant to the vice president in charge of engineering. He became associated with the Chevrolet division in May, 1935 and for the past several years was chief engineer of their light car division. During World War II he was supervisor of engineering for all wheeled vehicles produced by Chevrolet.

◆

WILLIAM C. JOHNSON recently was elected president of the National Electric Manufacturers Association. Mr. Johnson is executive vice-president in charge of the general machinery division of Allis-Chalmers Mfg. Co.

◆

DR. ACHILLE CAPECELATRO, assistant professor of physics at the Newark College of Engineering, has been appointed consulting engineer on product design for C-Eight Laboratories. Dr. Capecelatro had formerly been supervisor of the theory and analysis group at the United States Navy Underwater Sound Laboratory where he developed several special devices and computers. He is responsible for the Navy's new seven-and-a-half-inch standard compass and for a novel production method for testing permanent magnets.

◆

EUGENE S. CLARK is now associated with Solar Aircraft Co. as mechanical engineer on design of all types of gas turbine developments for aircraft, marine, prime movers and auxiliary power supplies.

◆

WILLIAM EMBRY WRATHER, director of the United States Geological Survey, has been elected president of the American Institute of Mining and Metallurgical Engineers.

◆

WOLFGANG E. MEYER resigned recently from North Carolina State College to become affiliated with the engineering experiment station of Pennsylvania State College as associate professor of engineering research.

◆

HOWARD W. CHRISTENSON has been transferred from the Detroit Transmission Division of the Allison Division of General Motors to the post of development engineer, working on the commercial transmission program at the Allison Division in Indianapolis.

◆

G. S. MCCANN has accepted the position of chief engineer of the Treen Engineering Co., New Orleans, upon resignation as director of research for the Walker Co., Racine, Wis.

BUSINESS AND SALES BRIEFS

APPOINTMENT of Roger G. DeLong as manager of the hydraulic division of the Twin Disc Clutch Co. has been announced. Mr. DeLong previously served as both acting manager and sales manager of the Rockford division. New sales manager, W. B. Gibson, was previously assistant district manager of the company's eastern territory.

◆

Main office and factory of the Euclid Electric & Mfg. Co., have been moved into a new building in Madison, Ohio. Additional space will enable the company to manufacture control equipment of larger capacity and greater variety than that presently produced. Branch sales office has been opened in Cleveland to serve customers in that area.

◆

The Penn metal Co. Inc. has announced the appointment of R. R. Gustafson as district sales representative for the Chicago territory. Mr. Gustafson will have his office in the Builders Bldg., 228 N. LaSalle St., Chicago 1.

◆

Formerly with the National Acme Co. and the Hydraulic Equipment Co., R. S. Koroncai has been appointed district sales manager in Ohio and western states for Scheneker Iron Works of Buffalo.

◆

Ball bearings manufactured by Jack & Heintz Precision Industries are now being handled by the sales and service organization of Ahlberg Bearing Co. Jack & Heintz will retain direct sales contact with its major established bearing accounts, but will be represented by the Ahlberg organization in securing additional customers.

◆

Announcement of the acquisition of the Warren Alloy and Machine Co. has been made by the Progressive Welder Co. The nonferrous foundry will serve as a source of heat-treated alloy castings.

◆

Two new sales offices have been opened by the Johnson Bronze Co. The Baltimore office is located at 1513 Guilford Ave.; the Denver office is at 1044-46 Broadway.

◆

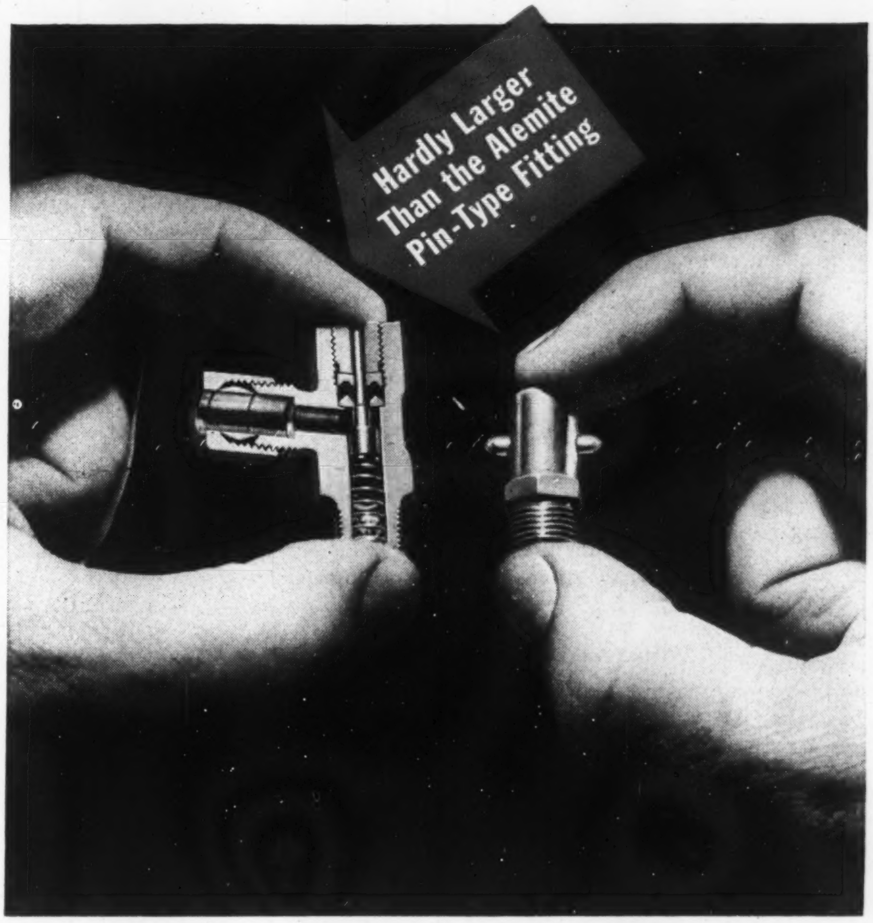
New plant of the McGill Mfg. Co. is undergoing construction in Valparaiso, Indiana. The new $300,000 plant will be a two-story brick building devoted to bearing-manufacturing facilities as well as to accommodating the company's general offices.

◆

In expanding its line of industrial products to include a general line of electric heating units, the Yale & Towne Mfg. Co. has appointed David Y. Robinson sales manager of electric heating units with offices in the Chrysler Building, N. Y. Mr. Robinson has over fifteen years of experience in the application and sales, including the position of sales manager of the industrial unit division

Another Alemite "Cost-Cutter"...

NEW ALEMITE "MIDGET" LUBRICANT MEASURING VALVE

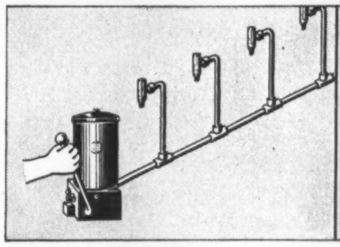


Now You Can Apply Low-Cost Centralized Lubrication to Any Machine

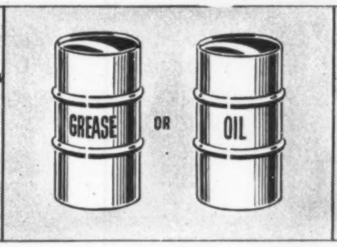
SMALL, SIMPLE, COMPACT . . . this new Alemite "Midget" measuring valve is less than 1½ inches long. In fact, it is not much larger than the popular Alemite fitting used on thousands of machines in every type of industry.

The small sizes of the "Midget," and its simple design, make it suitable for application to all types of heavy, light and precision machines—especially where space limitations are encountered.

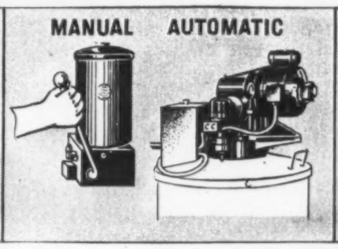
ASK FOR ANY TECHNICAL HELP. Alemite Lubrication Specialists will gladly work with you on any lubrication problems. Their training and experience enable them to render valuable on-the-spot assistance. For an interesting conference and demonstration, write to Alemite, 1804 Diversey Parkway, Chicago 14, Ill.



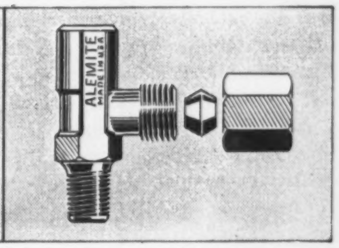
Low Cost, Single Line System. The valves can be mounted on or near bearings, to deliver a measured amount of lubricant from one central point while the machine is producing. No shutdowns, no bearing failures.



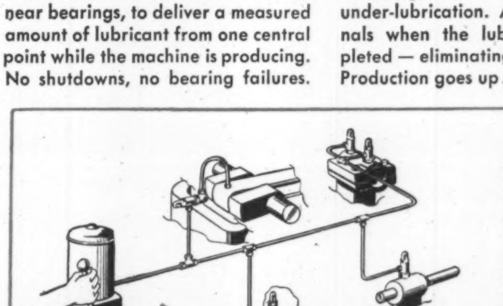
Handles Oil or Grease. There is no danger of over-lubrication or under-lubrication. An indicator signals when the lubrication is completed — eliminating human error. Production goes up . . . costs go down.



Manual or Automatic Operation. A hand pump may be installed in a safe, convenient place on the machine. Or, an Alemite air or electrically operated control will handle a group of machines automatically.



Built-In Compression Fitting is an integral part of the valve and included at no extra cost. No additional fitting is needed to connect tubing to the valve. This is an exclusive Alemite feature.



Serves Any Type of Bearing. Installation accessories are available so that the system can be adapted to rotary, oscillating, stationary — plain or antifriction bearings.

ALEMITE

REG. U.S. PAT. OFF.

Modern Lubrication that Cuts Production Costs

Another Product of
STEWART WARNER

of Tuttle & Kiff, Inc., and district sales manager handling Chromalox heating elements for the Edwin L. Wiegand Co.

◆

Sawyer Electrical Mfg. Co. has changed its name to A. O. Smith Electrical Mfg. Co., a subsidiary of A. O. Smith Corp. Address of the company is 5701 Smithway St., Los Angeles 22.

◆

Increase in manufacturing facilities for the Hornell, N. Y., plant of SKF Industries Inc. will result in an 80-per cent increase in production of pillow-block bearings. This is part of a two-year, 4-million dollar modernization program which is intended to increase by 50 per cent the output of spherical roller bearings made by the Philadelphia plants.

◆

Election of E. B. Cleborne to the office of executive vice president of Allegheny Ludlum Steel Corp. has been announced. Mr. Cleborne was previously vice president and director of the corporation.

◆

With headquarters at 14310 Woodward Ave., Detroit 3, D. J. Chapman has been appointed Michigan representative for the Essex Wire Corp. Mr. Chapman has served in the sales and engineering development department of the company for the last five years.

◆

Named resident vice president of Lindberg Engineering Co., L. W. Hayden will be in charge of all east coast sales offices, and in addition will be in charge of all export sales. He will continue to maintain headquarters at 420 Lexington Ave., New York City. G. W. Helsberg, formerly of the company's New York office is now in charge of the Boston office and R. W. Dougherty, formerly in charge of the Kalamazoo, Michigan office will be in charge of a new office in Philadelphia. S. K. Oliver, formerly in New York, will be attached to the Cleveland office, and T. M. La Crone, formerly with General Motors, has been placed in charge of the Kalamazoo office.

◆

Previously district sales manager of mechanical goods for the United States Rubber company's Cincinnati office, H. Barden Allison has been appointed sales manager of the Gilmer division, V-belt manufacturing unit in Philadelphia. Mr. Allison will be succeeded in Cincinnati by Ralph W. Stambaugh, a salesman in that district. Other personnel changes in the company's mechanical ~~goods sales organiz~~ation include the appointment of Purdy Miller as district sales manager in Indianapolis, and Paul S. Bigby as district sales manager in Milwaukee.

◆

Heretofore divisional manager for Link-Belt company's Caldwell plant products, James B. Elliott has been appointed divisional sales manager at the Minneapolis plant. Also, Erwin S. Wendell, previously district sales manager of the Chicago branch has been appointed divisional sales manager for Caldwell plant products with headquarters at that plant, while T. W. Matchett has been appointed district sales manager of the Chicago branch with headquarters at the Pershing Road plant.

◆

Plans for expanding manufacturing facilities at the Anaheim California plant of Essex Wire Corp. of California have been announced. This will enable the corporation to produce a complete line of wire and cable on the Pacific coast. A Paranite Wire and Cable Division of the Essex Wire Corp. of California is also planned for manufacturing and selling wires and cables, including all classes of construction wire and flexible cord.

◆

Desmond Gamble, formerly office manager of the McNally Pittsburgh Foundries, Inc., has been appointed sales representative in charge of sales in the western half of the country.

◆

Durling Electric Co., at 2002 St. Paul St., Baltimore, has been appointed district representative for Ward Leonard Electric Co. in the area of Virginia, south-central Pennsylvania, Maryland (except for the Washington area), and Delaware, south of Wilmington.

◆

Formerly with the Pittsburgh sales branch of Wagner Electric Corp., Preston M. Postlethwaite has been named manager of both electrical and automotive divisions of the Portland, Oreg., branch. Mr. Postlethwaite will direct the operations of the branch.

◆

Recently elected president of the Rogers Plastic Corp., North Wilbraham, Mass., Louis E. Martinelli will be assisted by Elmer F. Thompson, formerly associated with Milton-Bradley Co.

◆

R. G. Dailey, formerly sales manager of the Standard Products Co., is general manager of Wolverine Plastics, Inc., Milan, Mich., which he helped to organize.

◆

California Plastic Molding Co. and Lee Deane Products have merged to form Lee Deane Products Inc. The new organization will be located at 1708 E. 61st St., Los Angeles.

◆

Plastic Manufacturers Inc. has announced the election of the following officers: Chairman of the board, Myron A. Wick; president, Malcolm Farmer; vice president, Myron A. Wick Jr.; and secretary and treasurer, Ernest J. Johnson.

◆

Purchase of the Microfilm Recording Co., Chicago, has been announced by Bell & Howell Co. also of that city. All microfilm equipment manufactured and sold by Bell & Howell will be marketed under the trade name "Micro-Filmo".

◆

Expansion program of the Transmission Div. of Fuller Mfg. Co., Kalamazoo, Mich., includes additional space to its factory facilities. Some of it already had been placed in use, with the remaining addition to be completed in 1948.

◆

As manager of sales of General Electric's Heaters and Devices Section, R. W. Kise will be responsible for sales of Calrod heaters and heating devices for industrial use. Mr. Kise was formerly sales and application engineer in the Industrial Heating Division.

◆

Formation of a new firm, Industrial Product Sales Co., to manufacture forgings, ferrous castings, stampings, screw machine products, industrial wheels, and plastics used in the metal industry has been announced by the

Kodak

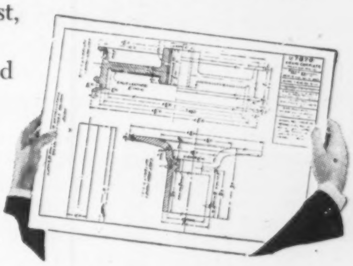
Eastman Kodak Company announces THE BIG NEW PLUS in engineering drawing reproduction . . .

Kodagraph Papers

With this—the announcement by Eastman Kodak Company, world's outstanding maker of photographic materials, of a new line of reproduction papers—you'd naturally expect a big new plus. And you're getting it: first—new Kodagraph Contact Paper which brings new features, new effectiveness to existing photographic reproduction methods. Second—revolutionary new Kodagraph Autopositive Paper that brings the unique advantages of photographic reproduction to direct process and blueprinting equipment.

The PLUS that Kodagraph Contact Paper brings to photocopying

Photographically, you can do things that can't be done any other way. You can get better printability from old and new drawings . . . reproduce blueprints, opaque drawings. And the plus Kodagraph Contact Paper brings to this is the assurance of brilliant contrast, wide latitude, flatness, long-lived legibility, and dependable uniformity.



The PLUS that Kodagraph Autopositive Paper brings to direct process and blueprinting equipment

Truly revolutionary . . . this new Kodagraph Autopositive Paper. Exposed in direct process or blueprint machines, it brings the advantages of photography to the making of masters of new tracings for highest quality prints . . . to the restoration of "unprintable" tracings, the reproduction of blueprints or opaque drawings. Does this directly—no negatives—in your present equipment, in ordinary room light.

See what this big new PLUS can mean to you—write for booklet

For unsurpassed photocopying—Kodagraph Contact Paper. For direct process and blueprinting equipment—Kodagraph Autopositive Paper. And for printing from reduced-scale negatives, there are Kodagraph Projection Papers. To survey the possibilities of this Kodagraph line—quickly—write for "The Big New Plus."

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Industrial Photographic Division
Rochester 4, N. Y.

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Just mail coupon

THE BIG NEW PLUS

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Industrial Photographic Division
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Please send me a copy of "The Big New Plus"—your booklet about the great new line of Kodak-made reproduction papers.
I have ☐ direct process ☐ blueprint ☐ contact printing equipment.

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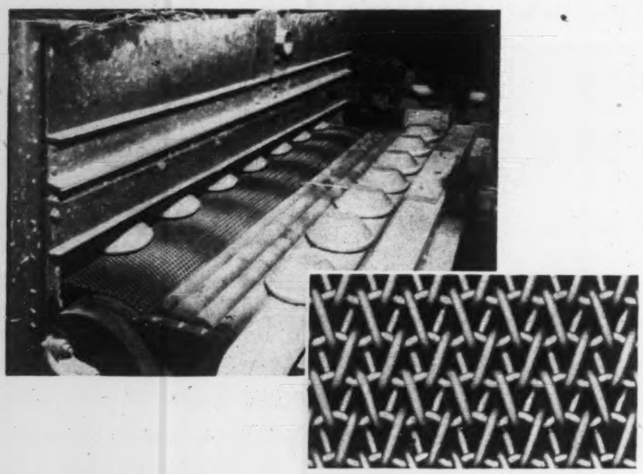
City____________State____________



Pottery processes *speeded* up . . . costs *slashed* through

INFRA-RED DRYING

on **CAMBRIDGE**

Balanced Belting

The right combination for more efficient, more economical production of pottery is Infra-Red drying on Cambridge Balanced Belting! Ideally suited for this high temperature drying operation because of its low thermal capacity—this flexible, open-mesh belting (see closeup insert) is available in various alloys to withstand temperatures up to 2050 degrees Fahrenheit. As in the Infra-Red pottery drying operation illustrated, production is speeded up . . . quality is improved . . . operating and heating costs are slashed with Cambridge Balanced Belting as the conveyor medium. You're wise to find out specifically how it can help you save time and money in all pottery processes. Write Dept. 21 for details.

Cambridge
CONVEYOR
BELTS

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. . . This illustrated technical handbook is a complete, practical reference for all belt users. Write Dept. 21 for your copy.

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partners, H. William Krantz Jr. and Edmund G. Siess Jr. The plant will be located at 1659 W. Market St., Akron 2, O.

◆

Formerly with the technical sales division of Leeds and Northrup Co., J. L. Highsmith has been appointed sales representative of C. P. Clare & Co. covering North and South Carolina. Mr. Highsmith's new address is Box 1367, Durham, N. C.

◆

Raybestos-Manhattan, Inc. has recently announced several appointments in its equipment sales division. Harry C. Dishman is the new equipment sales manager with headquarters in Detroit. George T. Young is branch manager of the Detroit office. E. E. Jergens has been appointed branch manager of the Cleveland office, and John E. Cole is the new branch manager of the Chicago office.

◆

W. A. Staublin has been appointed sales manager of hydraulic equipment for the hydraulic division of the Sundstrand Machine Tool Co., Rockford Illinois. Mr. Staublin has been associated with engineering and sales departments of the Hydraulic division since 1936.

◆

Establishment of a New England sales office has been announced by the American Nickeloid Co. of Peru, Indiana. In charge of this new division will be J. F. Schoellhorn, formerly of the company's Chicago office. Recent additions to the staff of two other Nickeloid Co. offices include Norman D. Standal in the Seattle, Washington office, and William Watts and John Richards in the Chattanooga, Tennessee office.

◆

Previously vice-president and treasurer of the RCA Distributing Corp., Chicago, W. Walter Young has been named comptroller of Redmond Co. Inc., Oswosso, Mich. Mr. Young's activities will cover accounting, financial and credit operations for this electric-motor manufacturing organization.

◆

Patrick E. McCaughey has been appointed merchandising sales manager of Federal Electric Products Co. Inc. with headquarters in the executive offices at Newark.

◆

Succeeding Fred H. Jones, who has retired because of ill health, E. B. Brant has been appointed district sales manager of the Page Steel and Wire Division of American Chain & Cable Co. Inc. He will make his headquarters at the Pittsburgh office, 908 Empire Building.

◆

Active in the sales organization of the Union Chain and Mfg. Co., for many years, George H. Harris has been appointed manager of the company's new Milwaukee office. His address is Wisconsin Tower Building.

◆

Associated with Lear, Inc. since 1940 in the capacity of vice president in charge of the electromechanical division, Richard M. Mock has been appointed executive vice president. This position has been relinquished by L. R. Raemer, the company's secretary and treasurer because of increased responsibilities arising out of an expanded development program.

◆

Cold Metal Products Co. of Youngstown, Ohio has announced five new appointments to its sales staff. Howard

This ring LOCKS Inserts or Studs to Parent Materials

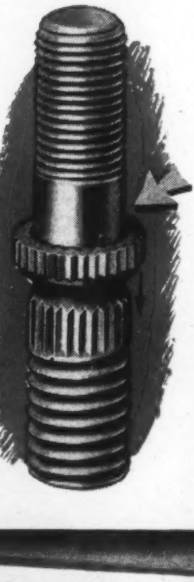
Rosán Locking System prevents loosening or turning—even under vibration

Studs and inserts become an integral part of the parent material with the Rosán Locking System. A ring, serrated both inside and out, locks its inner teeth with the mated collar on the stud or insert, and the outer teeth broach their way into the parent material. Result—a completely permanent installation that can't loosen or turn—yet can be removed easily, if desired, without injuring the parent material.

FASTENERS CAN'T PULL OUT OF SOFT MATERIALS with this Threaded Steel Hole

Rosán Inserts . . . give soft materials the strength of a steel tapped hole to hold fasteners in position under both tension and torque. A serrated ring locks the insert to the parent material so that it can't loosen, turn, or pull out of aluminum, soft metals, plastics or wood.

This threaded steel hole can be removed easily with an ordinary drill and any simple wedging tool—and replaced easily—without disturbing the parent material.



ROSÁN STUDS STAY TIGHT

Rosán Studs . . . can't loosen or turn—even under vibration—because the serrated ring locks the stud to the parent material. Rosán Studs can be removed and replaced easily—with simple tools.

Write today for a catalog showing applications of Rosán Inserts and Studs made by National.

NATIONAL
Rosán
THREADED INSERTS & STUDS
NATIONAL SCREW & MANUFACTURING CO.
NAT

National
HEADED AND THREADED
PRODUCTS

THE NATIONAL SCREW & MFG. COMPANY, CLEVELAND 4, OHIO

W. Smith is the new general manager of west-coast operations with offices at 6600 McKinley Ave., Los Angeles. C. N. Wrobbel has been appointed sales manager, and Frank D. Locker has joined the sales organization at the same office. William F. Skeer, also of the west coast area, has his offices at the Russ Bldg. in San Francisco. In the east, Sam M. Marshall will cover the New England territory with offices at 550 Fifth Ave., New York City.

◆

According to a recent announcement, W. S. Ginn has been appointed assistant manager of sales in General Electric company's power transformer section, transformer division. Mr. Ginn is a graduate of Georgia Institute of Technology and has been with the General Electirc Co. since 1936.

◆

Actively associated with the Falk Corp. since 1906 and named president in 1940, Harold S. Falk has recently been elected to the board of directors of Allis-Chalmers Mfg. Co. according to an announcement by Walter Geist, Allis-Chalmers president.

◆

Harold L. Hoefman, previously general manager of Link-Belt Co., Pershing Road plant, Chicago, has been elected vice president in charge of manufacturing. Succeeding him as general manager of the Chicago plant is D. E. Davidson, former head of the engineering department of that plant.

◆

With headquarters in San Francisco, Lewis M. Bound Jr. has been appointed west coast manager of Tube Turns, Inc. Mr. Bound joined the organization's New York sales staff in 1941.

MEETINGS AND EXPOSITIONS

Jan. 12-16—

Society of Automotive Engineers Inc. Annual meeting and engineering display to be held at Book Cadillac Hotel, Detroit. John A. C. Warner, 29 West 39th St., New York, is secretary and general manager.

Jan. 12-16—

National Materials Handling Exposition and conference to be held at Public Auditorium, Cleveland. Further information may be obtained from Clapp & Poliak, 350 Fifth Ave., New York.

Jan. 26-29—

Institute of Aeronautical Sciences. Sixteenth annual meeting to be held at Hotel Astor, New York. Robert R. Dexter, 2 East 64th St., New York 21, is secretary.

Jan. 26-29—

Refrigeration Equipment Manufacturers Association. Fifth all-industry refrigeration and air conditioning exposition to be held at Public Auditorium, Cleveland. F. J. Hood, Clark Bldg., Pittsburgh, is chairman of the show.

Jan. 26-30—

American Institute of Electrical Engineers. Winter general meeting, William Penn Hotel, Pittsburgh. H. H. Henline, 33 West 39th St., New York 18, is secretary.

Feb. 2-6—

American Society of Heating and Ventilating Engineers. Fifty-fourth annual meeting and 8th international heating and ventilating exposition to be held at Grand Central Palace, New York. Charles F. Roth, Grand Central Palace, New York 17, is manager of the exposition.

JUST WHAT YOU ORDERED!
BARNES-GIBSON-RAYMOND

B-G-R springs are served up the way you want them, with particular care to the fine points that give ease of assembly and satisfying operation. Scientific control of design and production methods insures strict adherence to specifications throughout.

Make assurance doubly sure. Ask B-G-R to check your spring specifications for those factors that may influence cost and performance.

Small Orders served separately

Individual attention to small lots or experimental springs in special departments equipped for efficient service.

SPRINGS
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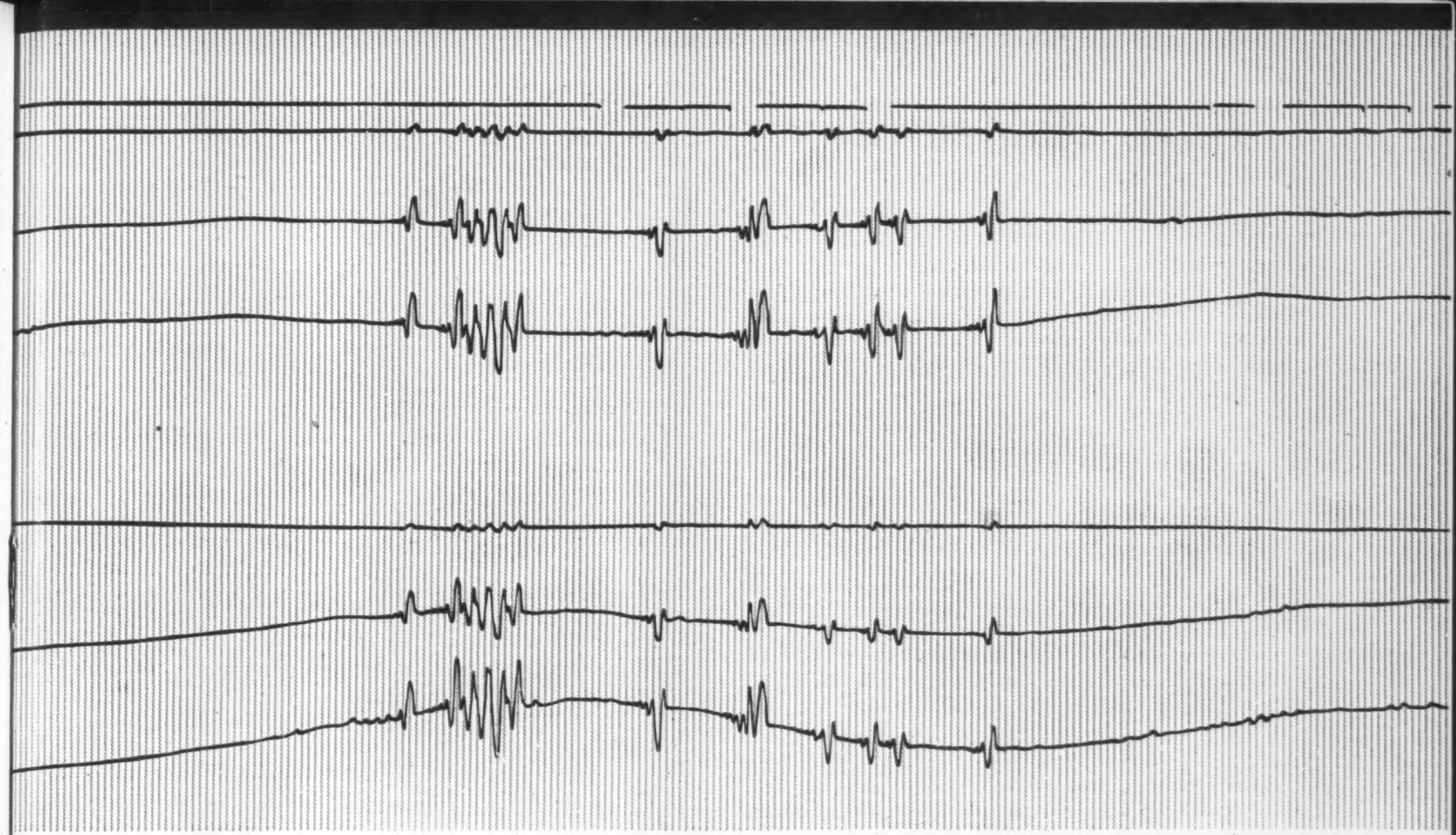
TWO PLANTS FOR SPRING SERVICE

DETROIT 11, MICHIGAN
ANN ARBOR, MICHIGAN



Picture of a bridge groaning under load...

. . . photographic stress analysis is one of many industrial uses for light-sensitive Kodak recording materials.

By cementing strain gauges smaller than postage stamps to external surfaces, test engineers can find out about structural behavior deep inside the material under stress . . . so sensitive is the response of these little devices to vibration and strain.

An important contribution to such sensitivity in instruments of this type is the wide latitude of Kodak photographic recording materials that are available. These may be had in all sizes and speeds for nearly every type of instrument.

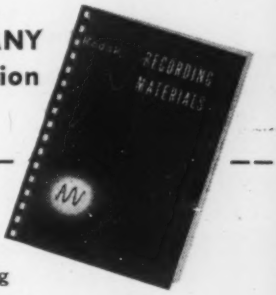
Instrument Recording

. . . another important function of photography

Kodak is continually developing new recording products, and is glad to discuss them with you—so your new instruments may take full advantage of the finest in photographic recording.

Why not utilize the greater sensitivity and speed of photographic recording for your instruments? Why not find out how well the new Kodak high speed recording papers will work in your equipment? Just write to

EASTMAN KODAK COMPANY
Industrial Photographic Division
Rochester 4, N. Y.



Eastman Kodak Company
Industrial Photographic Division
Rochester 4, N. Y.

☐ Please send me your book "Recording Materials."

☐ Please send information on your new high speed recording papers.

Name____________________

Company____________________

Department____________________

Address____________________

City____________________

State ____________________

Kodak

NEW MACHINES

And the Companies Behind Them

Agriculture

Rubber-tired dozer. Speed selections range from 1.91 to 15.24 mph forward and reverse. Features air-actuated controls, finger-tip steering and blade operation, and single brake pedal. R. G. LeTourneau Inc., Peoria, Ill.

Air Conditioning

Fume separator. For cleaning contaminated air without loss of room heat, by water absorption and centrifugal separation. Electroplating Co. Inc., Indianapolis.

Blower. In small or large sizes, from 4 to 47 in., in single or double-width types, equipped with low-speed forward curve blades. Johnson Fan & Blower Corp., Chicago 7.

Automotive

Duster-deduster. Injects into inner tube at extrusion die a carefully proportioned stream of compressed air and soapstone. Excess soapstone is withdrawn by vacuum. Whittington Pump & Engineering Corp., Indianapolis 4.

Business

Standarized electric stairway. Designed especially for small and medium sized retail stores. Of 27-inch, single-file type, stairway has rise of 22.5 feet. Westinghouse Electric Corp., Pitsburgh 30.

Domestic

Unit ventilator. Has resilient belt drive mechanism, mounted in rubber at all points of stress. Speed variation easily obtained by adjusting vari-pitch sheaves. The Trane Co., La Crosse, Wis.

Electric clock. For office, den or living room, in mahogany or blond birch case and brass base. Dimensions: 4⅝ x 7¼ x 2¼ inches. General Electric Co., Bridgeport 2, Conn.

Small electric casserole. Available in two models—one with an automatic temperature control with range of 100 to 550 F, and the other with a two-heat control for both fast and slow cooking. General Electric Co., Bridgeport 2, Conn.

Table radio. Arc dial model, in blond or mahogany. Has 7 tubes plus rectifier to give 6.5 watts of undistorted output, full range tone and automatic volume control. Westinghouse Electric Corp., Pittsburgh 30.

Clock. Shelf type. For timing household chores for periods up to 30 minutes. Timer set by pull-out knob on right side of dial. General Electric Co., Bridgeport 2, Conn.

Radiant gas conversion burners, gravity gas furnaces, and forced circulation gas furnaces. Iron Fireman Mfg. Co., Cleveland.

Alarm clock. With translucent ivory plastic face which lights up for easy reading of dial. Light is turned on by means of switch. General Electric Co., Bridgeport 2, Conn.

Radio. Three-way portable type in a luggage type cabinet of simulated pigskin. Designed with a superheterodyne circuit for greater sensitivity, with 5 tubes plus selenium rectifier, for ac, dc or battery operation. Westinghouse Electric Corp., Pittsburgh 30.

Television instrument. Five-in-one unit, it utilizes a direct viewing tube with a 54 sq in. image. Cabinet has compartments for television, AM-FM and shortwave,

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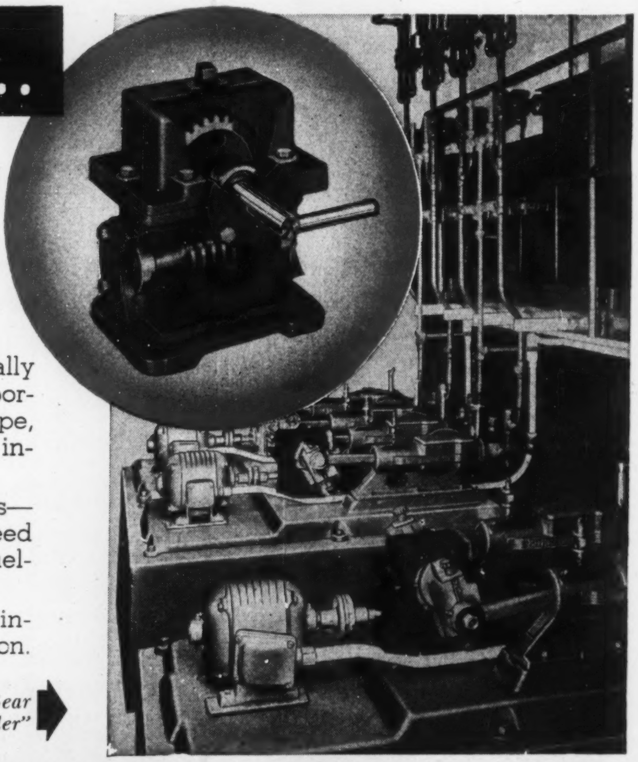


WHS VERSATILITY...

matched only by the

DEPENDABILITY

of these SPEED REDUCERS

% Proportioners, Inc. %, of Providence, R. I., nationally known for "engineering, equipment and service on proportioning problems", use the WHS "B" Series Horizontal Type, Single Reduction Worm Gear Speed Reducer—as an integral part of their "Adjust-O-Feeder".

Selected by well over 100 widely differing industries—this is another indication of the **versatility** of WHS Speed Reducer equipment. And it stands up under the most grueling punishment!

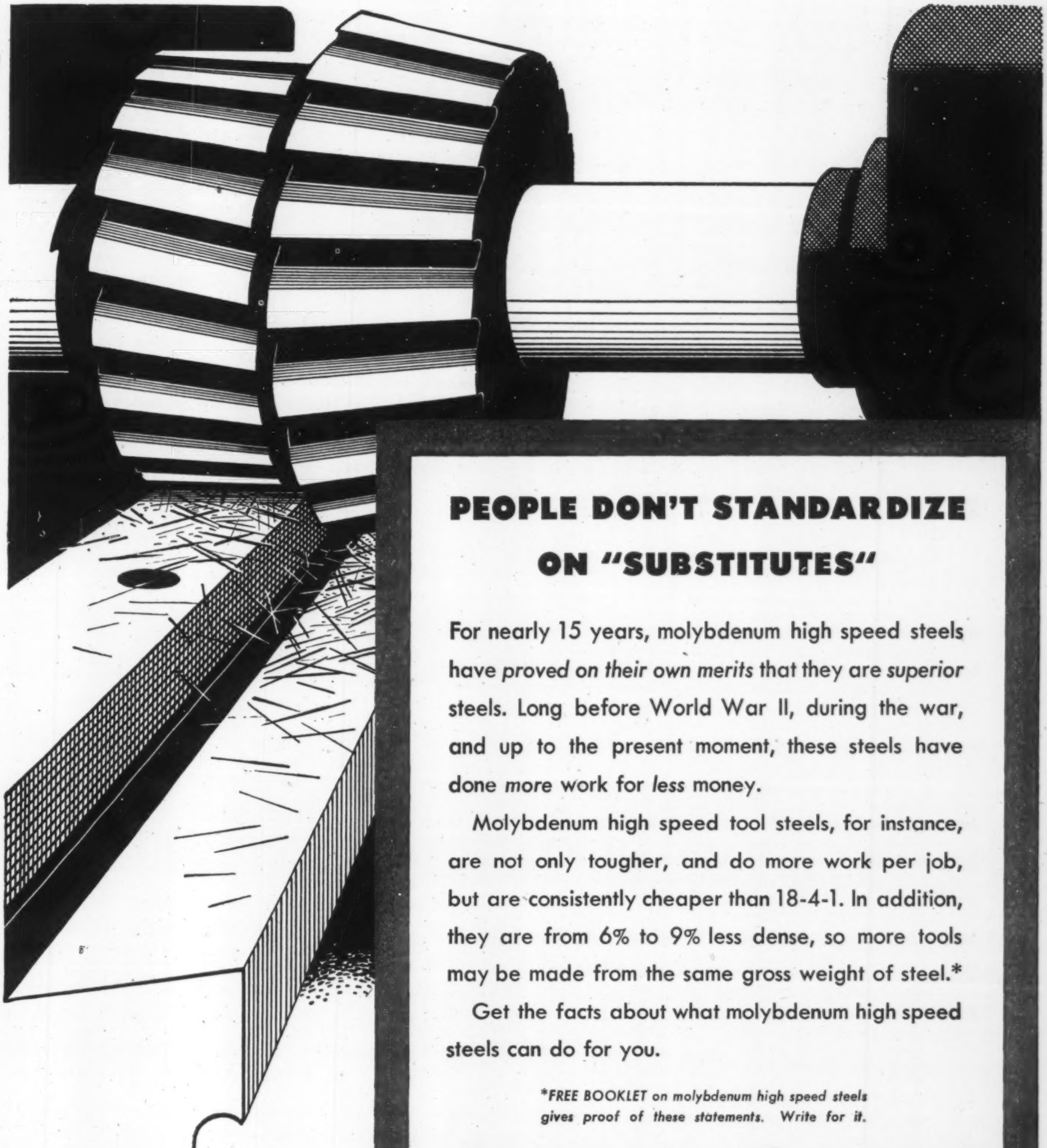
Your file should contain our Catalog. It includes a comprehensive engineering section. Send for it!

MEMBER OF AGMA

At right . . . Series "B" WHS Worm Gear Speed Reducer in a typical "Adjust-O-Feeder" installation.

WINFIELD H. SMITH CORPORATION

16 ELTON STREET . . . SPRINGVILLE . . . ERIE COUNTY . . . NEW YORK



PEOPLE DON'T STANDARDIZE ON "SUBSTITUTES"

For nearly 15 years, molybdenum high speed steels have *proved on their own merits* that they are *superior* steels. Long before World War II, during the war, and up to the present moment, these steels have done *more* work for *less* money.

Molybdenum high speed tool steels, for instance, are not only tougher, and do more work per job, but are consistently cheaper than 18-4-1. In addition, they are from 6% to 9% less dense, so more tools may be made from the same gross weight of steel.*

Get the facts about what molybdenum high speed steels can do for you.

***FREE BOOKLET** *on molybdenum high speed steels gives proof of these statements. Write for it.*

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CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

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Silicone News

DC SILICONES

Silicones Reduce Size and Weight of Totally Enclosed Non-ventilated Motors

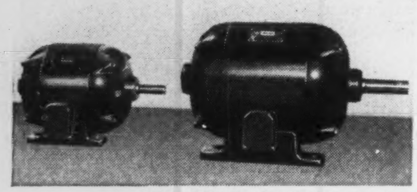

PHOTO COURTESY WESTINGHOUSE ELECTRIC CORP.

New 5 h.p. totally enclosed, non-ventilated Westinghouse motor (at left) protected with Silicone Insulation has same rating as much larger motor (at right) wound with Class A insulation.

This is the kind of industrial news we like to report. It's the story of that new Silicone insulated, totally enclosed, non-ventilated motor made by Westinghouse. This motor weighs only 60% as much as a comparable motor of conventional design. It requires no more space than an open motor of the same rating, and it is comparable in overall performance.

This very significant reduction in size and weight is a result of skillful designing to capitalize upon the exceptional heat stability of the silicone resins and varnishes developed by Dow Corning. These silicone varnishes are not affected by the somewhat higher operating temperatures which are caused by the relatively small radiating surface. The hottest spot temperature rise of this motor is within the 140°C. permissible for this new class of electrical insulation.

This new motor also incorporates another example of progressive engineering in the use of new materials. Its bearings are permanently lubricated with DC 44 Silicone Grease. Consequently, they require no attention for at least five years, in spite of the somewhat higher temperatures at which they operate.

The introduction of this new Silicone insulated motor marks a new era in electrical insulation. The use of Silicone Grease in the bearings marks another major step in the direction of permanent lubrication.

Silicones have been responsible for all sorts of improvements in design and performance, ever since we started to produce them on a commercial scale nearly five years ago. Our experience in putting these new engineering materials to work is at your service. We'll be glad to send you our catalog B 1-6 which describes DC Silicone resins, greases, fluids and Silastic.*

*TRADEMARK FOR DOW CORNING SILICONE RUBBER

DOW CORNING CORPORATION
MIDLAND, MICHIGAN
New York • Chicago • Cleveland • Los Angeles
In Canada: Fiberglas Canada, Ltd., Toronto
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Dow Corning
FIRST IN SILICONES

Dow Corning Silicone Products include

FLUIDS
- Damping
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- Dielectric
- Waterproofing
- Lubricating
- Diffusion Pump
- Mold Release

GREASES
- High Temperature
- Low Temperature
- Valve Lubricants
- Stopcock
- High Vacuum

COMPOUNDS
- Ignition Sealing
- Antifoam A

RESINS
- Electrical Insulating
- Laminating
- Protective Coatings

SILASTIC*
- Molding
- Extruding
- Coating
- Laminating

*Trade Mark Dow Corning Corporation

automatic record changer, and record storage space. Garod Radio Corp., Brooklyn 1.

Electronic oven. For heating meals in about 75 seconds. Designed for heating precooked frozen foods only. General Electric Co., Schenectady, N. Y.

Radio. Table-size with large inclined lighted dial, with 14 to 1 ratio. Has five tubes plus rectifier. Westinghouse Electric Corp., Pittsburgh 30.

Radio. Combination console model having AM-FM phonograph. Has ten tubes plus rectifier and phono amplifier. Westinghouse Electric Corp., Sunbury, Pa.

Radio. Straight AM-FM console having ten tubes plus rectifier. Westinghouse Electric Corp., Sunbury, Pa.

Phonograph-console. Providing full width record storage space for 52 albums or 350 single records. Westinghouse Electric Corp., Sunbury, Pa.

Radio. Console combination with 12 tubes and rectifier and tuning eye. Features four bands, disappearing speaker, and 25 watts of undistorted output produced by dual speaker arrangement. Westinghouse Electric Corp., Sunbury, Pa.

Radio-phonograph console. Incorporating standard broadcast and FM radio, and a phonograph with automatic record changer. Radio Corp. of America, Camden, N. J.

Piano. Miniature, weighing 80 pounds. Dimensions: 38¼ x 22⅞ x 7½ inches. Equipped with standard legs, height is 31¼. Has 64 notes. Pratt Read & Co., Ivoryton, Conn.

Gravity oil furnace. Equipped with vaporizing oil burner. Is of mechanical draft, vaporizing type with built-in automatic electric oil-air control. United States Radiator Corp., Detroit.

Foundry

Separator. High-power complete inclined magnetic pulley type, in combination with revolving screen. Magnetic Engineering & Mfg. Co., Clifton, N. J.

Industrial

Electronic (or dielectric) heater. Radio waves oscillate 30,000,000 times per second through material to be heated, creating heat almost instantly, regardless of thickness of material. Radio Frequency Corp., Boston 34.

Heater. Special-purpose four-station resistance electric type to accommodate knee action control arms, prior to forging operation. Agnew Electric Co., Milford, Mich.

Automatic disintegrator. For removing broken taps, drills, studs, reamers, etc., from die sections, castings, hardened steel, brass, bronze and most any alloy. Ansaldi Tool & Engineering Co., Detroit 8.

Furnace. Gas-fired, fully enclosed. Offered in two temperature ranges, 1400 to 1800 F and 2000 to 2500 F. Eclipse Fuel Engineering Co., Rockford, Ill.

Dust collector. Uses hard-pressed wool felt as filter medium. Annular blow ring hugs and flexes the cylindrical felt bag while moving up and down its outer surface by means of chain and sprocket drive. Pulverizing Machinery Co., Summit, N. J.

Gas alarm system (remote head type). Principle utilizes effect of combustion of flammable gas-air or vapor-air mixtures on a heated filament in the analyzer head. When mixtures reach preselected percentage of lower explosive limit, a series of relays close to sound an audible signal and to control appliances. Davis Emergency Equipment Co. Inc., Newark 4.

Instrument

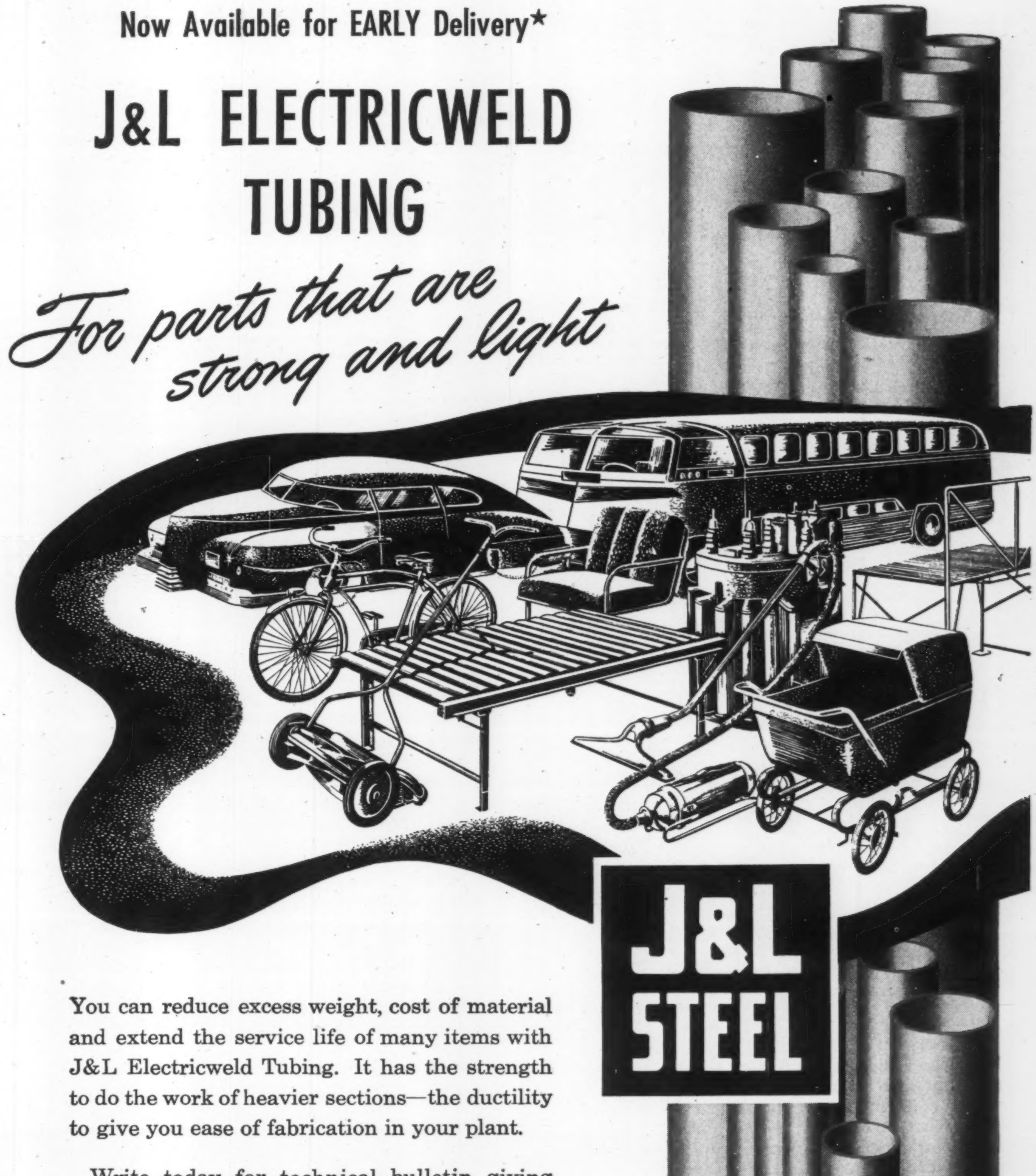
Microscope. Toolmaker's. For shop inspection. George Scherr Co. Inc., New York 12.

Recorder. The Model PL has features such as the

Now Available for EARLY Delivery★

J&L ELECTRICWELD TUBING

For parts that are strong and light



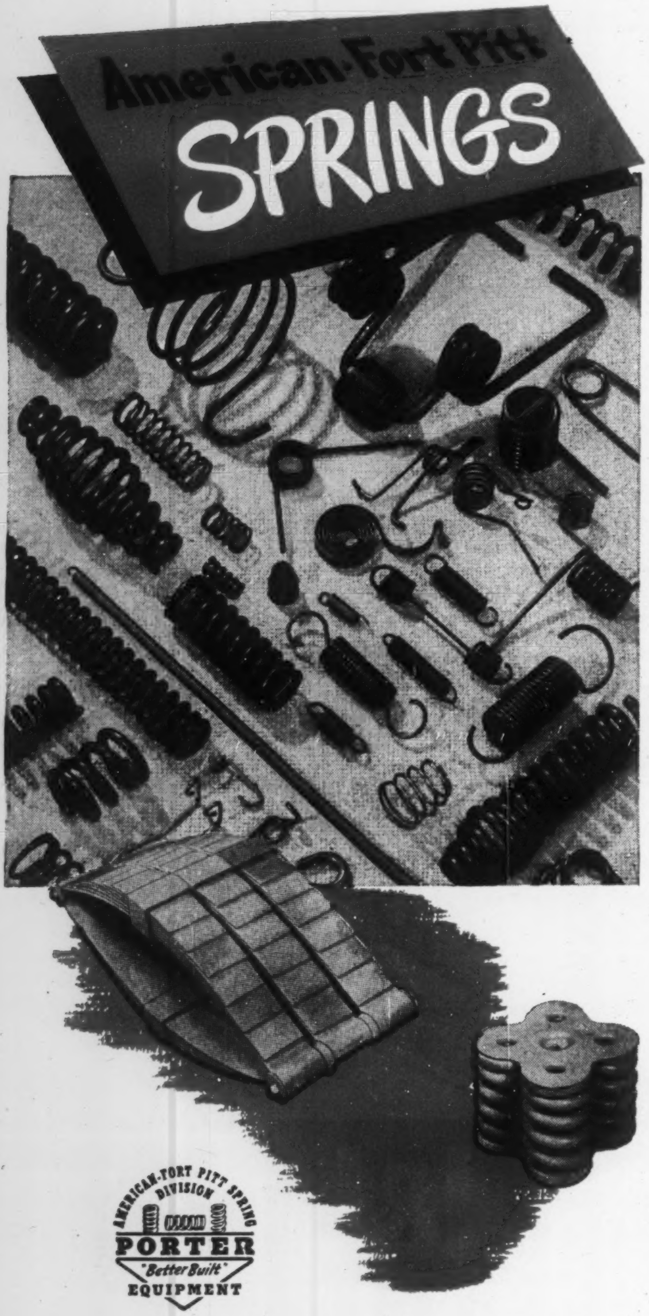
You can reduce excess weight, cost of material and extend the service life of many items with J&L Electricweld Tubing. It has the strength to do the work of heavier sections—the ductility to give you ease of fabrication in your plant.

Write today for technical bulletin giving you complete information on J&L Electricweld Tubing and how it can be applied to improve your products at less cost.

★ Due to an extensive plant expansion program J&L Electricweld Tubing is now available for early delivery.

JONES & LAUGHLIN STEEL CORPORATION

PITTSBURGH 30, PA.



The merger of American Spiral Spring & Mfg. Co., and Fort Pitt Spring Co. has brought together two of the oldest spring manufacturers to form one of the *largest* spring producers in the country. This combined equipment and experience offers exceptionally complete facilities for the manufacture of all types of springs, from heavy coil and elliptic springs for cars and locomotives, to the smallest helical wire and flat springs for all purposes. Our engineering facilities are at your disposal to help solve your intricate spring problems.

PORTER-BUILT *means* BETTER-BUILT

American-Fort Pitt Spring Division
H. K. PORTER COMPANY, Inc.
PITTSBURGH 22, PENNSYLVANIA
District Offices in Principal Cities

three pushbutton-operated paper speeds and easier accessibility to recording mechanism, scriber and potentiometer train. Sound Apparatus Co., New York 7.

Materials Handling

Lift truck. Hook has an outreach of approximately 4 ft, lifting up to 18,000 lb. The Yale & Towne Mfg. Co., Philadelphia.

Electric hoists. Capacities of 250 to 2000 lb. Design features incorporate grooved drum to accommodate a full 12-ft lift with no overwinding, pushbutton control and preformed wire rope with swaged fittings for anchoring. Wright Hoist Div., American Chain & Cable Co. Inc., York, Pa.

Mechanized wheelbarrow. Capable of carrying one-ton load at speeds up to 15 mph. Has airplane type tires, aircooled, 6-hp engine and 4-speed transmission. Novo Engine Co., Lansing, Mich.

Fork truck. Central control, small and light in weight. has capacity of 1000 lb. Has 36-in wheelbase and overall length, exclusive of forks, of 53⅝ in. The Baker Industrial Truck Div., The Baker-Raulang Co., Cleveland.

Fork truck having lifting capacity of 15,000 lb. Towmotor Corp., Cleveland 10.

Hoist unit doubles as jack for easier lifting and pulling jobs. Rated capacity is 2000 lb. Weight of hoist is 23 lb complete. Coffing Hoist Co., Danville, Ill.

Metalworking

Pull-down machine and a pull-up machine—both available in 5 and 10-ton models. Colonial Broach Co., Detroit 13.

Special machine tool for combining four finishing operations on a cylinder block with clutch housing assembled. The Cross Co., Detroit 7.

Air-operated presses. All force is provided by air pressure, with only two simple valves for operator to manipulate. One style provides rated tonnage of press at 145-lb air pressure, the other at 90 lb. Dake Engine Co., Grand Haven, Mich.

Automatic screw machine for all normal operations with exception of thread cutting on stock up to 1-in. diam. Standard Machinery Co., Providence, R. I.

30-ton combination shear and press. Requires 36 x 75 in. floor space. Stroke is 2 in., as is the ram adjustment. Bed die space is 12 x 36 in., ram die space, 10 x 36 in. Parker Mfg. Co., Santa Monica, Calif.

Air-lubricated hammer. Has a loose or sloppy fitting piston requiring only a few drops of oil each month to prevent internal corrosion. Dow Pneumatic Tool Co., Chicago.

Double-end riveter. Horizontal type using "rotating impact" principle which combines precision-controlled straight-line pneumatic hammer blows, with a fluted, rotating peen. Lemert Engineering Co., Plymouth, Ind.

Punch press. 70 and 100-ton capacities. Has self-energizing brake, being applied only at the moment of clutch disengagement. Superior Punch Press Co., Cleveland.

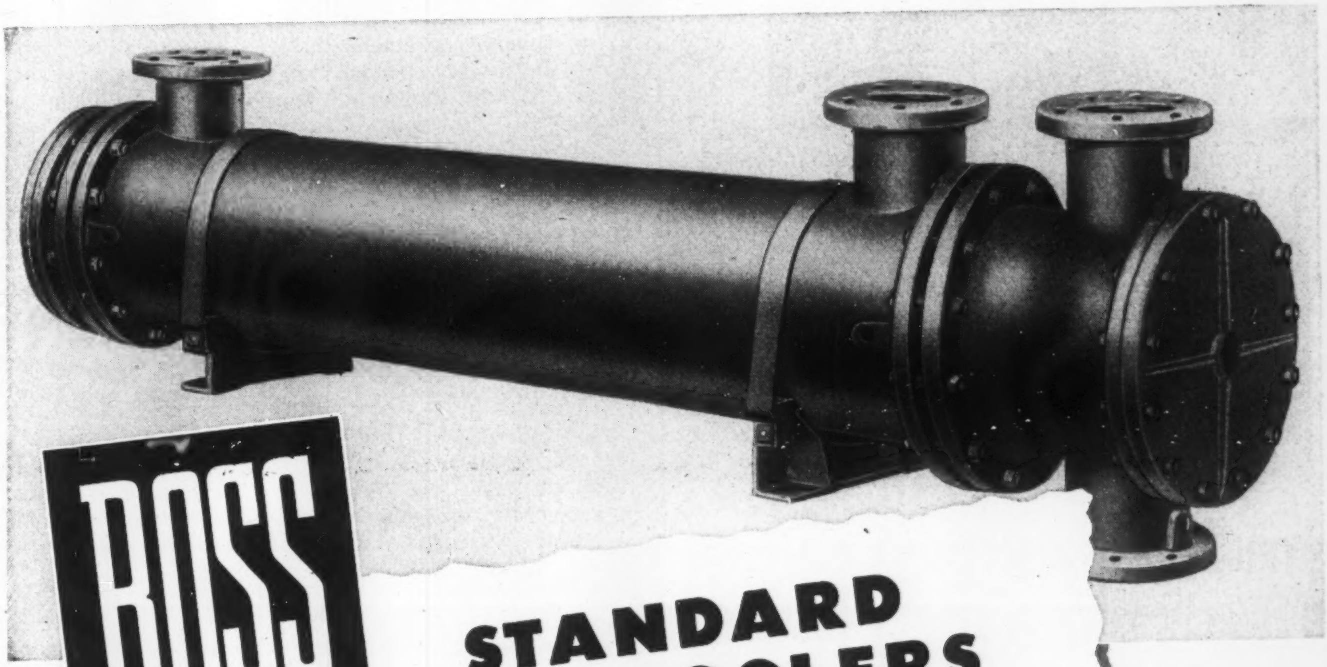
Riveting hammer. High-speed with 24-in. steel arbor, especially suited to sheet metal work. The High-Speed Hammer Co., Inc., Rochester 5, N. Y.

Drilling and tapping machine. Portable horizontal type with a tilting head for unlimited drilling and tapping operations. Kaukauna Machine Corp., Kaukauna, Wis.

Shapers. For producing shapes other than gears, such as cams, overrunning clutches, splines, etc. Shapes are cut by formed tools which feed in radially from all sides during the cut. Michigan Tool Co., Detroit 12.

Deep-drawing press. Hydraulic double-action type, operating at high speed. Pushbuttons are provided to

why more cooling requirements and more operating conditions are served than with any other make



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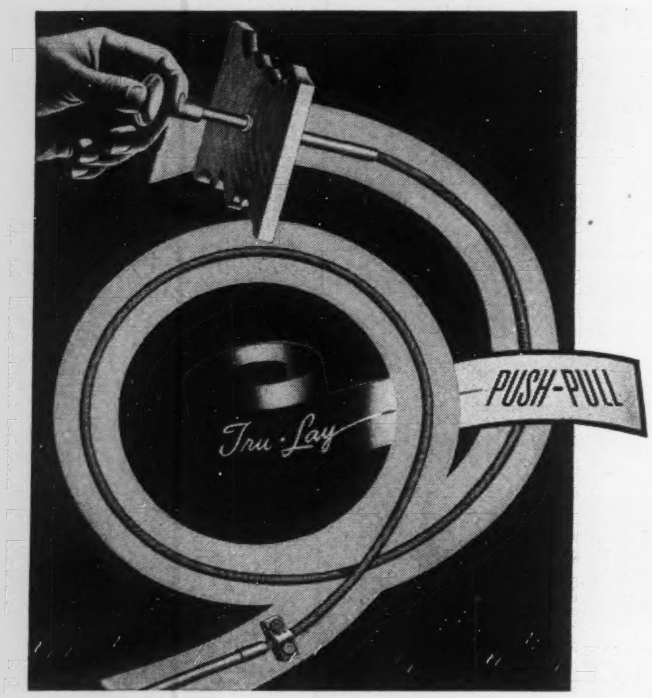

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actuate valves by means of solenoids. Main slide has capacity of 100 tons. Hydropress Inc., New York 22.

Plastics

Molding machine. 3-ounce injection type. Hydraulic Machinery Inc., Dearborn, Mich.

Compression press. 24 x 24 in. six-opening hydraulic press has an initial pressure of 2000 psi giving plate pressure of 614 psi or total capacity of 177 tons. Farrel-Birmingham Co., Inc., Ansonia, Conn.

Processing

Mixer. Continuous process unit designed to eliminate batch mixing. Handles material ranging from viscosity and density of bread dough to liquids, at controlled rate of 5 to 1000 gpm. Marco Co. Inc., Wilmington, Del.

Testing

Stiffness tester. Motor-operated for paper, textiles, plastics, metal foil, leather and sheet materials. Gurley Engineering Instruments, Troy, N. Y.

Gas analyzer. For determining and analyzing the concentration of gases or vapors in their toxic range. Works on principle of electrical conductivity of solutions. Davis Emergency Equipment Co. Inc., Newark 4, N. J.

Transportation

Trucks. Extra heavy duty. Utilize valve-in-head engines of 513 cubic inch displacement developing 170 gross horsepower and 602 cu in. displacement, developing 200 hp. Capacities range up to 76,000 lb. Reo Motors Inc., Lansing, Mich.

Vending

Vending machine. Fruit juice dispenser is a multichoice, coin-operated unit. Holds 300 six-ounce cans at a time, fifty in each. Telecoin Corp., New York.

Vending machine. Coin-operated. Dispenses fresh fruit at price range from 1 to 10 cents, automatically returning correct change with selection of fruit. Kold-Krisp Apple Service Inc., Van Nuys, Calif.

Welding

Spot welder. Can be ganged for multiple welds. Bench-mounted, the unit incorporates controlled air-operated electrode pressure, adjustable current setting, electronic timing, water cooling of transformer and electrodes, and automatic pressure initiation of current. Metron Instrument Co. Denver 9.

Welder. Hydraulic projection type for high-production welding of gasoline-engine push-rod assemblies at rate of 1200 per hour. The Federal Machine & Welder Co., Warren, O.

Welder. Triple head projection type for welding mounting brackets to cooling fins on compressor assemblies. With a machine cycle of approximately 5 seconds, it produces 150 assemblies per hour. Federal Machine & Welder Co., Warren, O.

Combination battery charger and arc welder. Available in two models: 30 amp charger and 75 amp welder; and 10 amp charger and 55 amp power factor corrected welder. Larkin Lectro Products Corp., New York 30.

Welder. Double-roll, traveling-head, series-seam type. Designed for use in strip mills and other plants where it is desirable to join strip ends or skelps for long machine runs. The Federal Machine & Welder Co., Warren, O.

Welder Designed for ac "Heliarc" welding, using helium or argon for shielding. For welding hard-to-weld metals. The Hobart Bros. Co., Troy, O.

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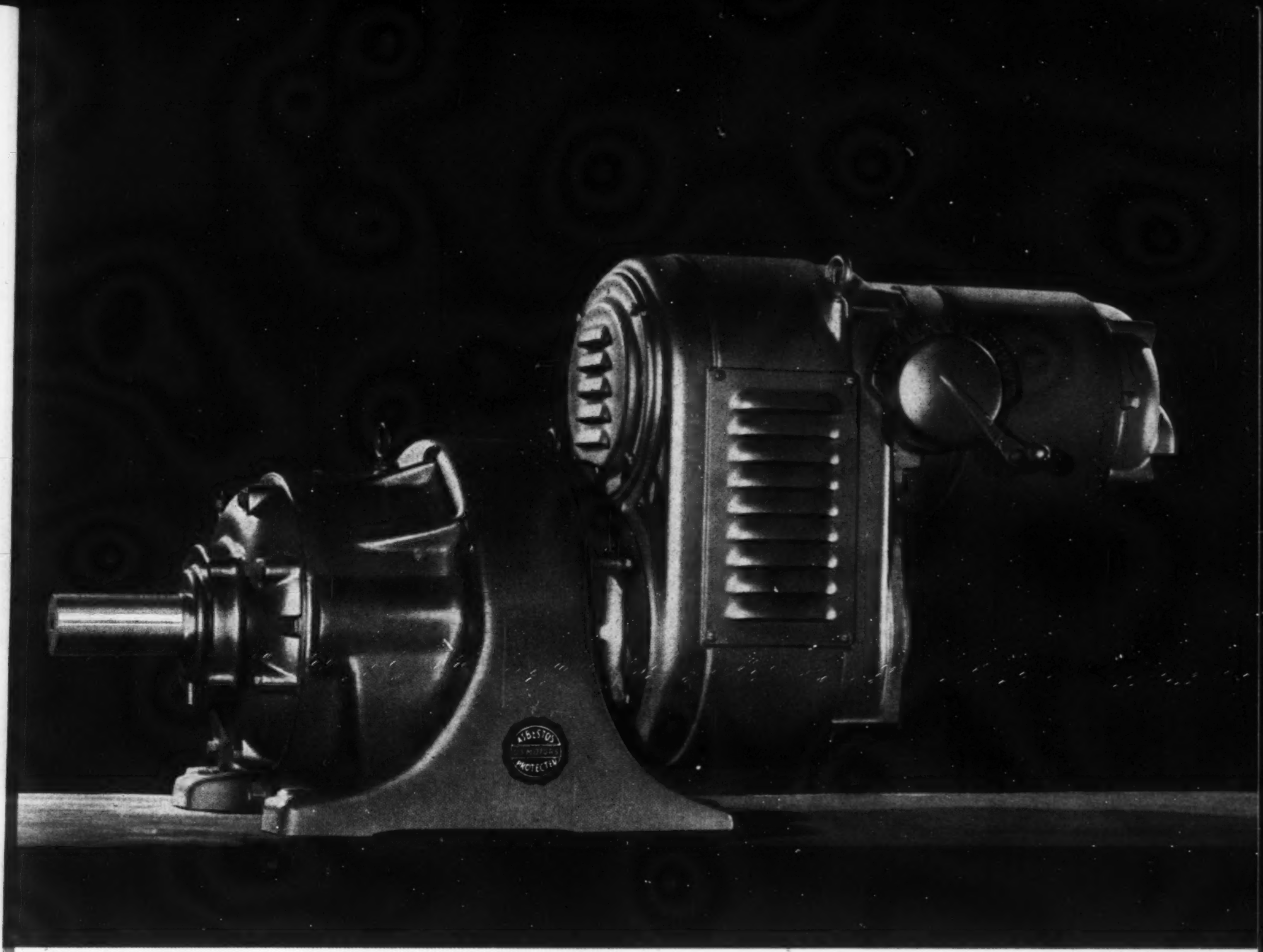

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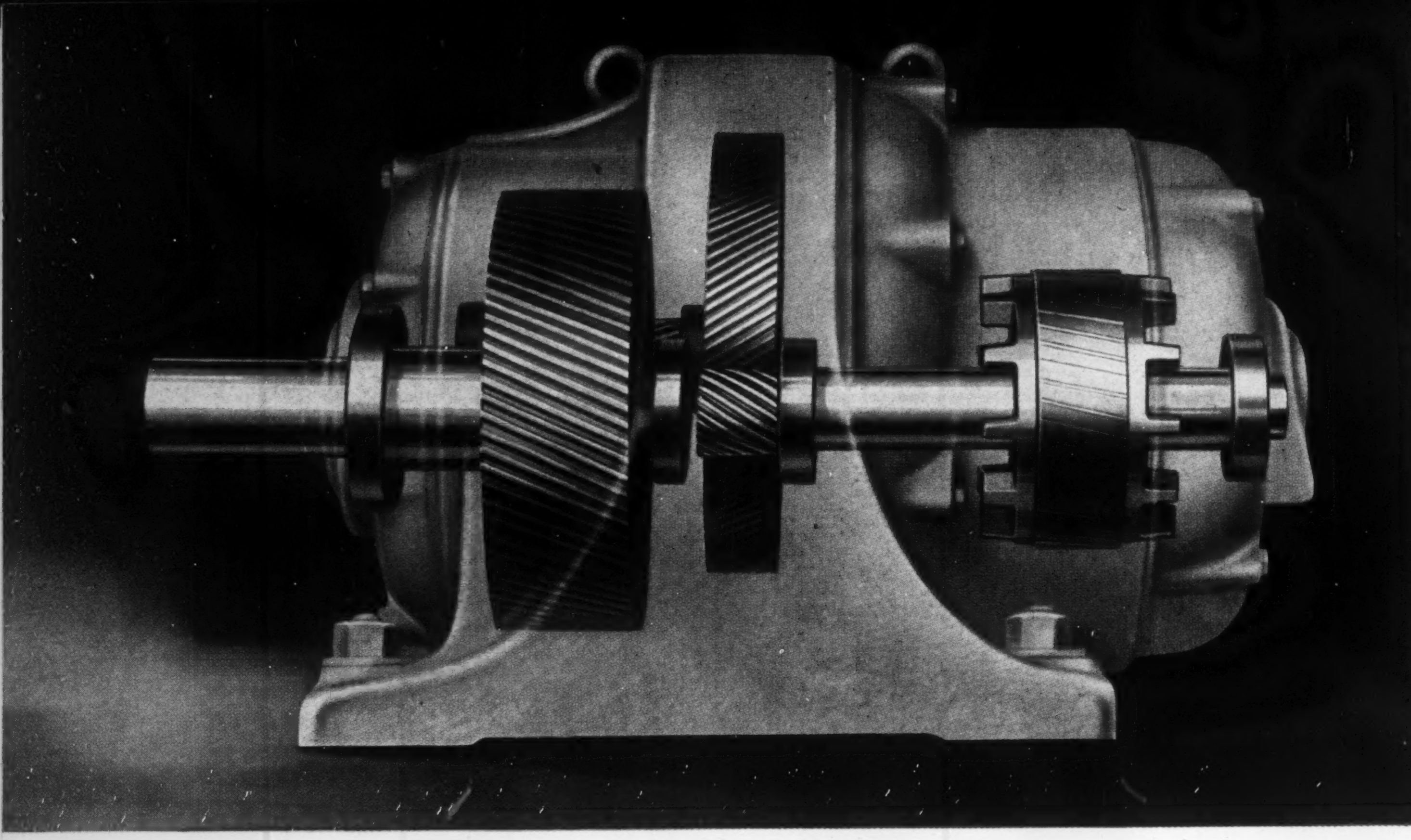

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Stronger, Lighter Hand Truck Made by Welding Tubular High Carbon Steel

BY JAMES B. HOWLAND, PARTNER
TUBAR BENDING & MANUFACTURING CO., CLEVELAND, OHIO

THE new Tubar Hand Truck has outstanding strength and low weight because it is made of tubular high carbon steel with an exceptionally thin wall (.076″). Frame of the largest model Tubar weighs only 36 pounds, yet carries a 1,000-lb. load. Fig. 1 shows how light it is. The addition of reinforcing tubes from the kick-bar to the handle (see Fig. 3) makes a "stevedore" model with a 2,500-lb. capacity. Conventional hand trucks of these capacities weigh more than twice as much.

The all-welded tubular frame has other advantages in addition to lightness. Constructed without bolts or rivets, it has a smooth top and bed without obstructions. There is no danger from wood splinters or sharp edges of metal. Design of the frame distributes the load and reduces dead weight on the axle, facilitating handling. The operator's hands follow the curve of the handle in "breaking" the load to a pulling or pushing position. The Tubar Truck is patented.

JIGS USED IN WELDING

We use two sizes of tubing—1$\frac{1}{16}$″ O.D. and $\frac{7}{8}$″ O.D. The smaller telescopes into the larger size at the maximum stress point, for greater strength. The tubes are bent on a bending machine (see Fig. 2). The toe plates are bevelled and forged to a point. Toe-plate sides are cut from $\frac{3}{4}$″ high carbon steel plate by an acetylene cutting machine. The frame parts are assembled in a jig and tack-welded, then finish-welded in another jig (see Fig. 3).

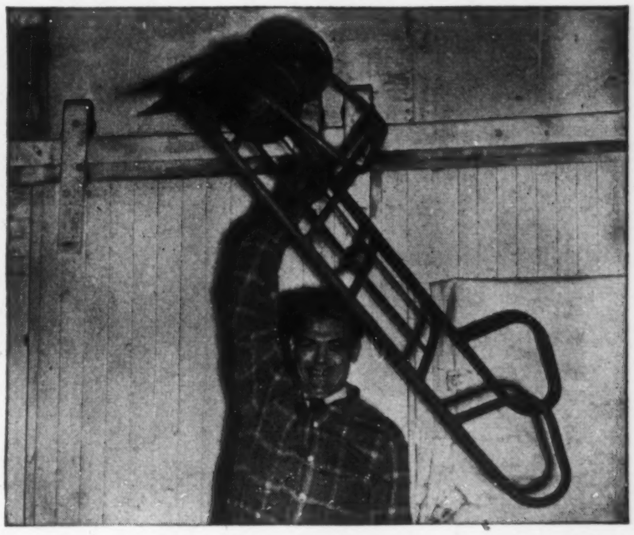

Fig. 1. Demonstrating the lightness of the Tubar truck.

In setting up production, we had difficulty welding the high carbon tubing until we tried the new Lincoln "Shield-Arc LH-70" electrode, designed for high carbon and other difficult-to-weld steels. With "Shield-Arc LH-70" we are able to weld speedily without costly preheating or special welding procedures.

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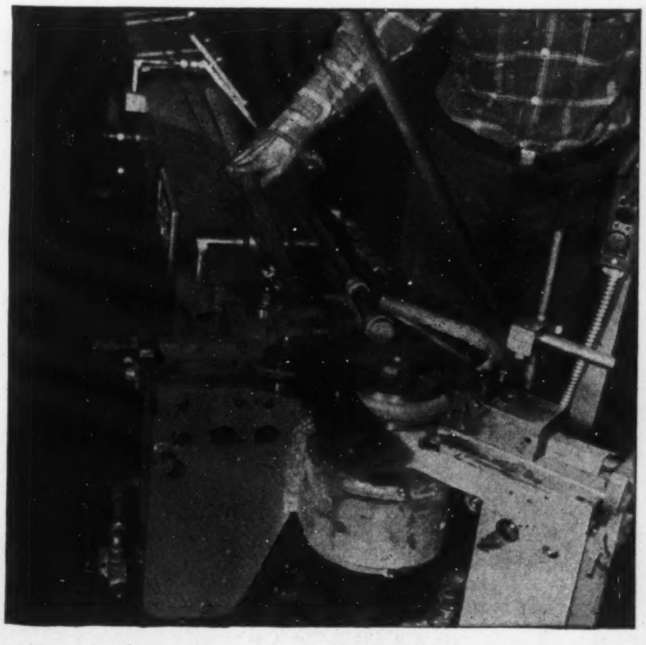

Fig. 2. All bending is performed on a tube bending machine.

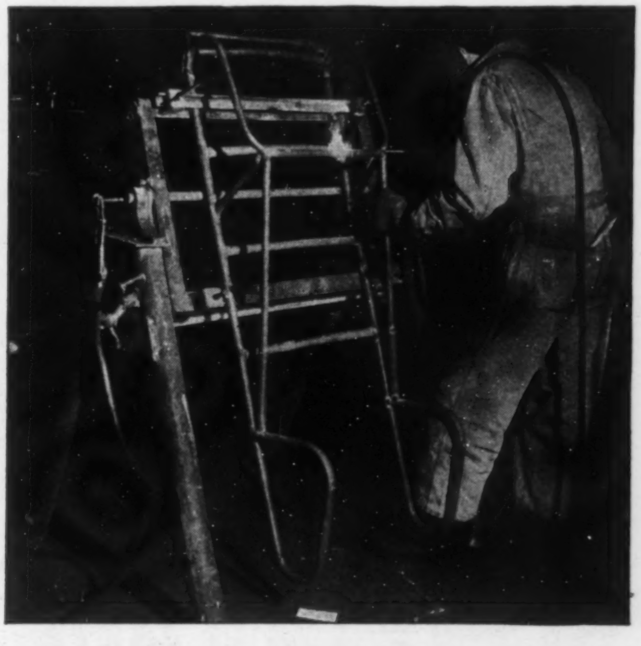

Fig. 3. Finish-welding a "stevedore" model. Jig rotates so most welding is in downhand position.

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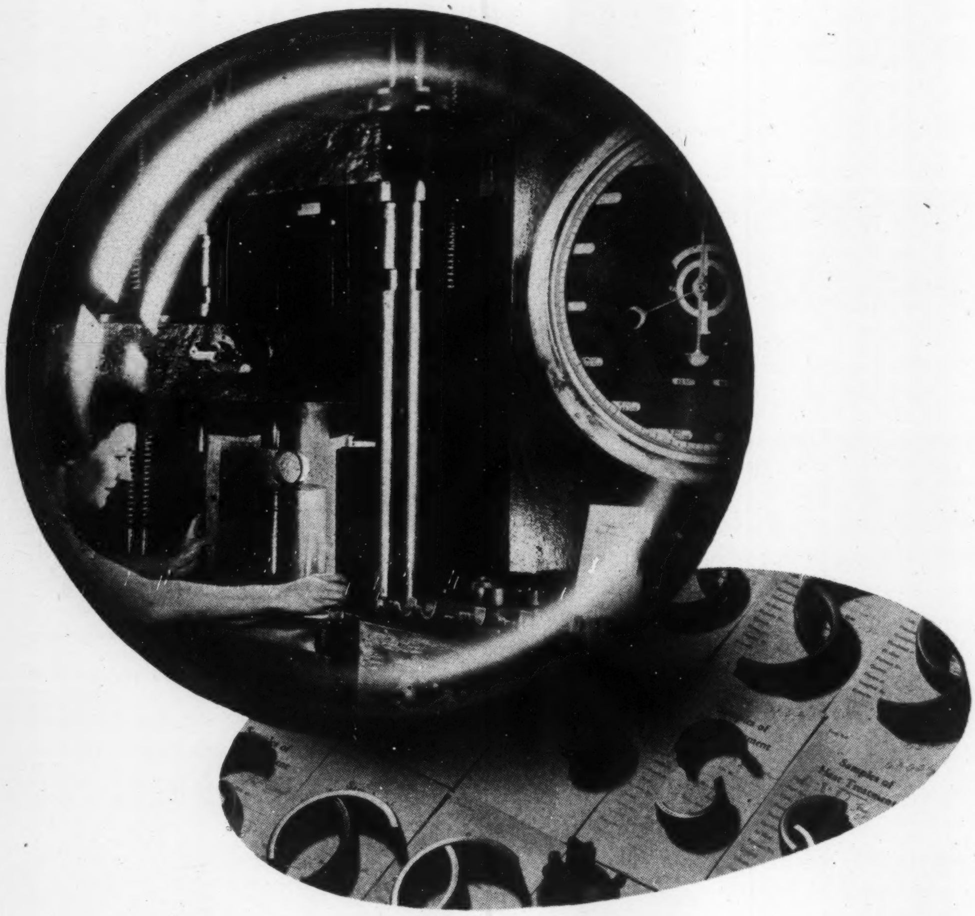

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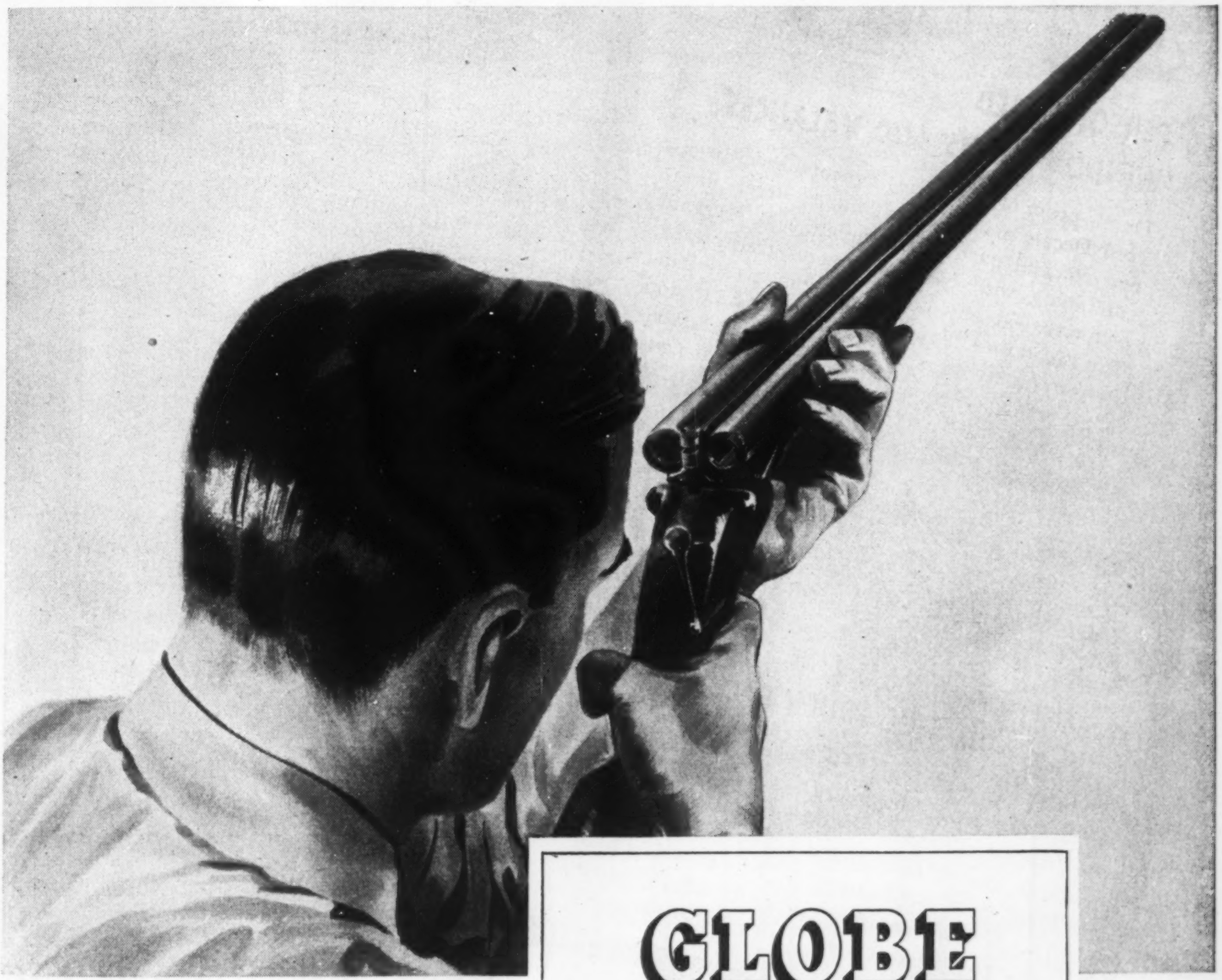

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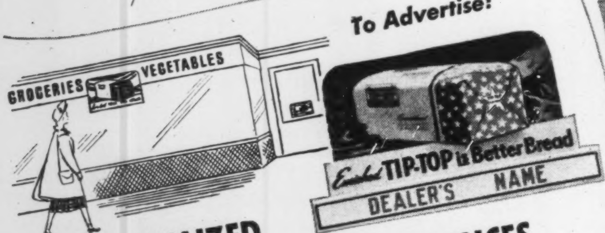

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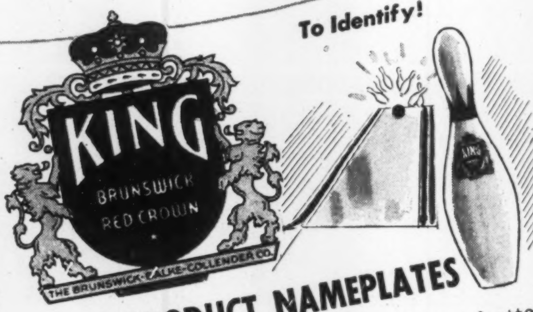

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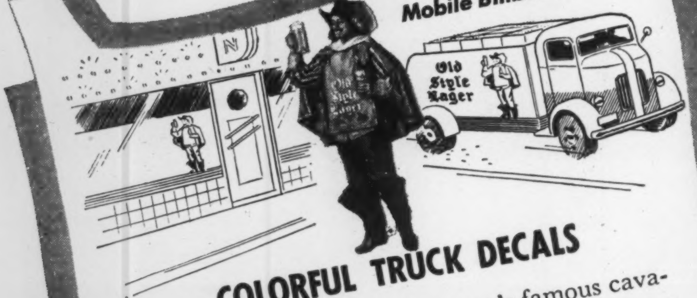

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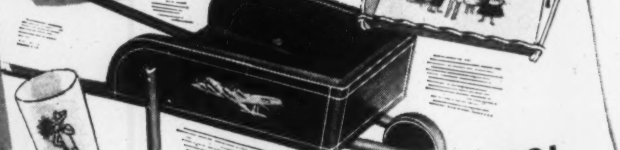

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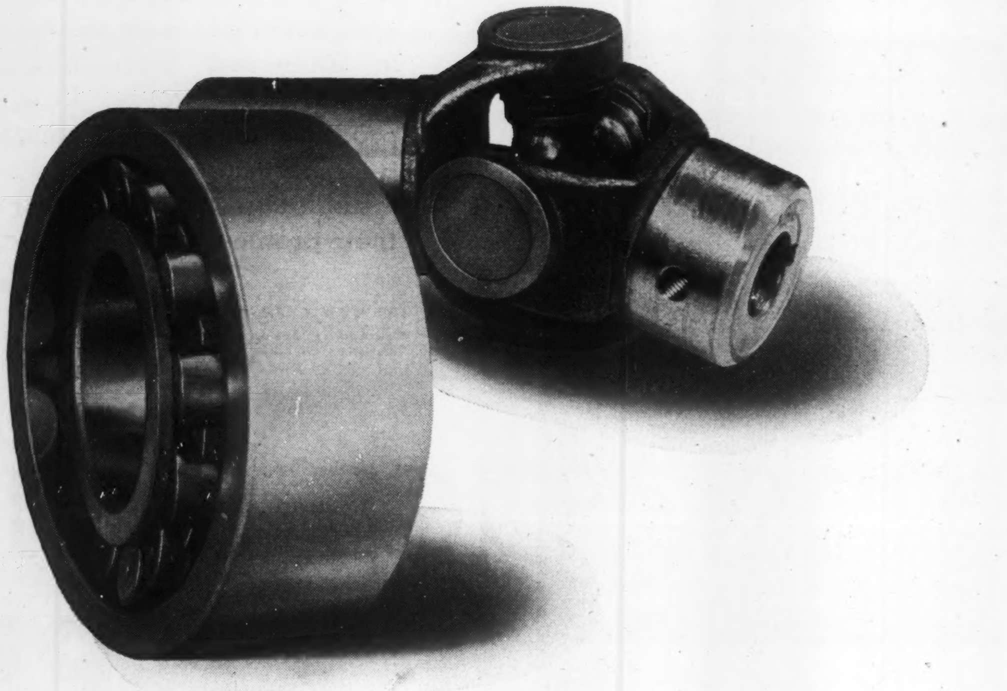

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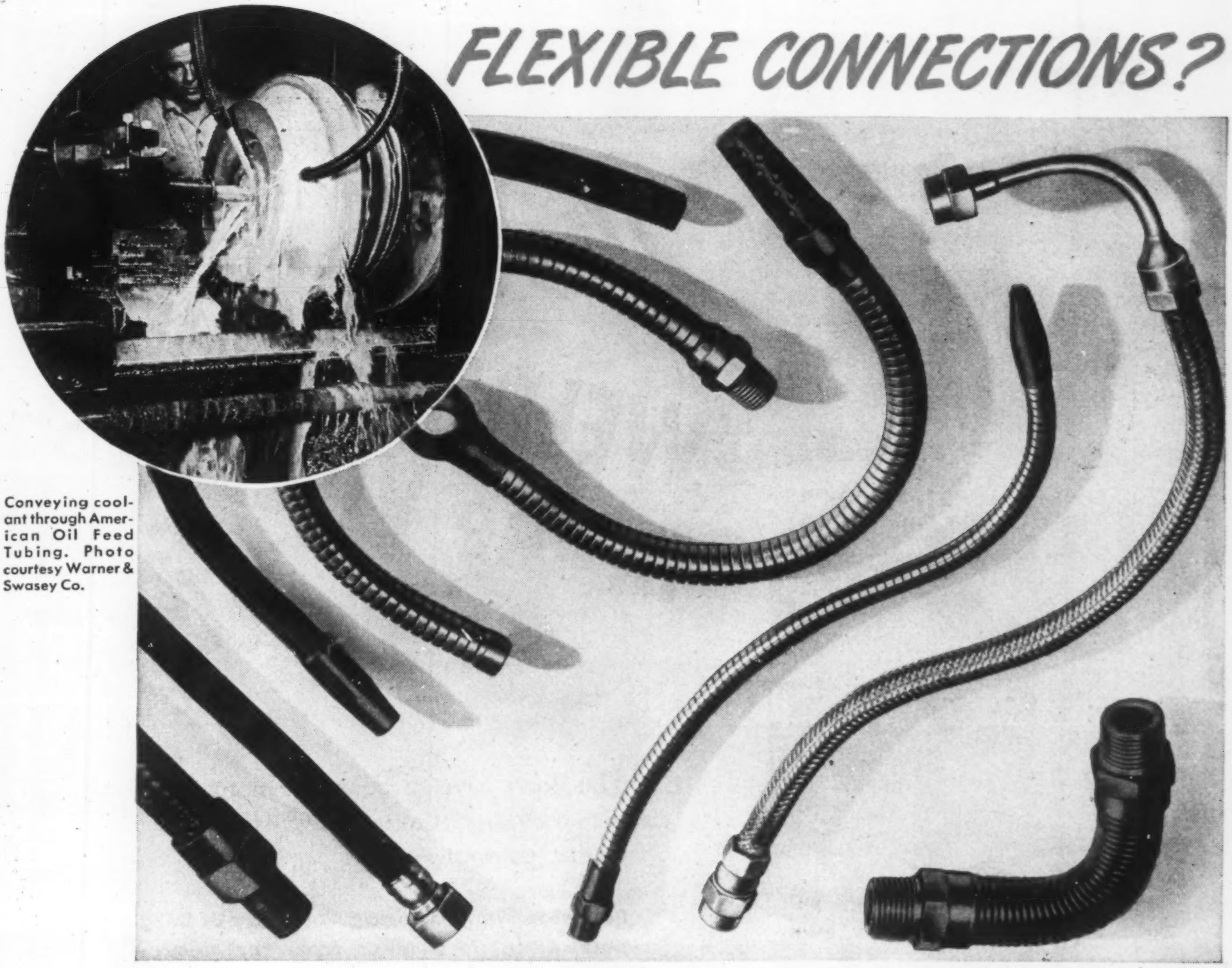

Conveying coolant through American Oil Feed Tubing. Photo courtesy Warner & Swasey Co.

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ABOVE are samples of special flexible metal connectors, tailor-made by American with end fittings attached. Such assemblies simplify the job of design and production departments throughout industry.

Available in brass, bronze, aluminum, steel and other metals, in sizes 1/8" to 12" I.D., American Metal Hose is manufactured from strip in four spirally wound types. American Seamless Flexible Metal Tubing, flexible as garden hose and as leakproof as the seamless bronze tube from which it is made, is standard in sizes 1/8" to 4" I.D.

Whether your problem is one of vibration, misalignment, connecting moving parts or piping in cramped spaces, if it involves conveying steam, oil, water and other liquids, semi-solids or gases, look to American Flexible Metal Hose or Tubing for an economical solution. Write for literature, and feel free at any time to consult our Technical Department.

47297

ANACONDA
from mine to consumer

American

METAL HOSE

THE AMERICAN BRASS COMPANY

American Metal Hose Branch

General Offices: Waterbury 88, Connecticut

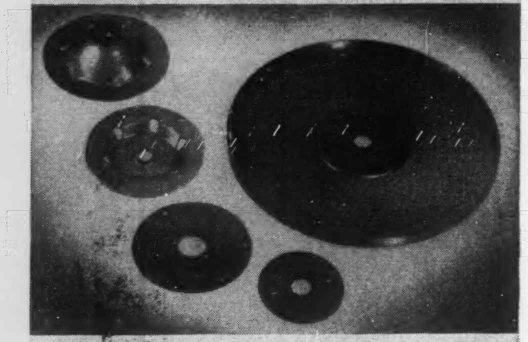
Subsidiary of Anaconda Copper Mining Company

Throughout Canada:

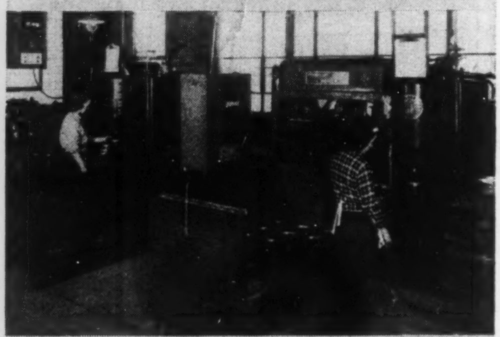
THE CANADIAN FAIRBANKS-MORSE CO., LTD.

DESIGNED for Resistance Welding

From the top all phonograph turntables look alike, but . . .



. . . underneath, they are all different—each manufacturer has his own idea as to mounting brackets, yet . . .



. . . Precision makes them all by projection welding them on 2 PROGRESSIVE battery-operated machines.

There's "WELDINGENUITY" in the VILLAGES—*too*—

You don't have to be in the heart of a high electric power district to take advantage of the economies that go with *designing for resistance welding.*

Precision Manufacturing Company of Bergholz, Ohio, is 5 miles from the nearest sub-station but is turning out close to 14,000 phonograph turntables EACH DAY for 15 different manufacturers on just TWO WELDING MACHINES.

How? Precision uses two Progressive Welder *battery-operated* machines, which do not need high power lines and assembles the parts by *multiple* projection welding—in ONE OPERATION.

With this set-up, Precision became the largest manufacturer of phonograph turntables.

How about re-designing some of your parts so that you can make them better *and cheaper?* Call in Progressive's Process Engineering Department, today.

IT PAYS TO WELD

CABLE ADDRESS "PROGWELD"

MEMBER RWMA RESISTANCE WELDER MANUFACTURERS' ASSOCIATION

PROGRESSIVE *Welder Co.* 3050 E. OUTER DRIVE • DETROIT 12
RESISTANCE WELDING EQUIPMENT

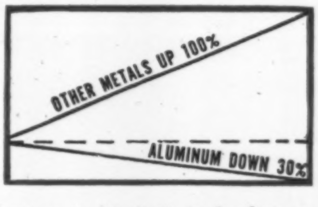
WHAT HAVE ALUMINUM TRUCK BODIES GOT TO DO WITH MY PROBLEM?

JUST THIS. They proved that a change to aluminum from other materials so improved product performance that the consumer thinks of this lightweight metal in terms of savings rather than cost.

"Too costly", said truck body builders before the war. But today they find that with aluminum at an all-time low and its light weight offering 3 times the working area of steel on a pound for pound basis that it is practically a "must" metal. And these "pay-off" advantages appeal to the consumer—greater pay loads, lower fuel costs, increased tire mileage, freedom from rot and rust and even lower license fees.

Remember, too, aluminum's light weight favors the manufacturer as well as the consumer. Pound for pound, aluminum gives three times the working area of steel, brass or copper. It is easier to handle on the production and assembly lines; often eliminates one or more finishing operations and costs less to ship. In other words, add up *all* the savings and you are likely to find that you can offer the advantages of aluminum at the same cost or less.

Yes, there are many factors that go to make up the true cost of aluminum. Failure to consider them all may be costing you the benefits of this modern metal. Reynolds technicians will welcome the opportunity to work with you in the use of aluminum for the betterment of your products and profits. For complete information contact your local Reynolds Sales Office or write Reynolds Metals Company, 2521 South Third Street, Louisville 1, Kentucky.

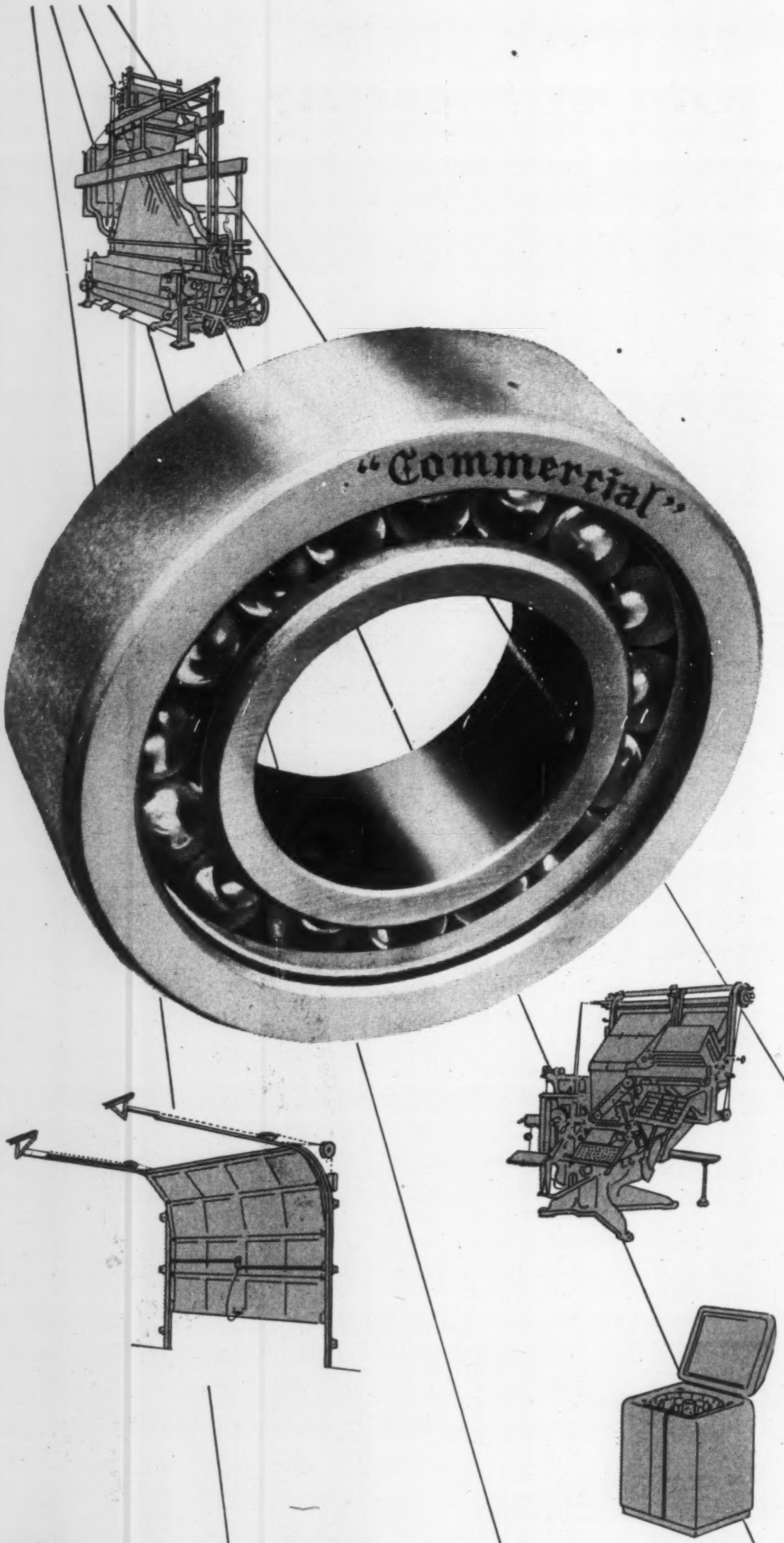


The price of aluminum has been reduced 30% since Reynolds became a primary producer in 1939.

REYNOLDS METALS

REYNOLDS
THE GREAT NEW SOURCE OF **ALUMINUM**

INGOT • SHEET • SHAPES • WIRE • ROD • BAR • TUBING • PARTS • FORGINGS • FOIL • POWDER



SCHATZ "COMMERCIAL" BALL BEARINGS have a knack for calling the turn wherever anti-friction performance is the need and low initial cost the problem.

Unlike other moderate-priced ball bearings, "Commercials" combine *through-hardened* chrome alloy precision balls and high-grade, carburized, hardened and tempered cold-rolled steel rings. What a difference this makes in added load capacity, resistance to fatigue and maintenance-free bearing life! That's why "Commercials" are equally at home in linotype machines and dishwashers, garage doors and jacquard looms, or in any bearing application which calls for day in and day out operating efficiency and economy.

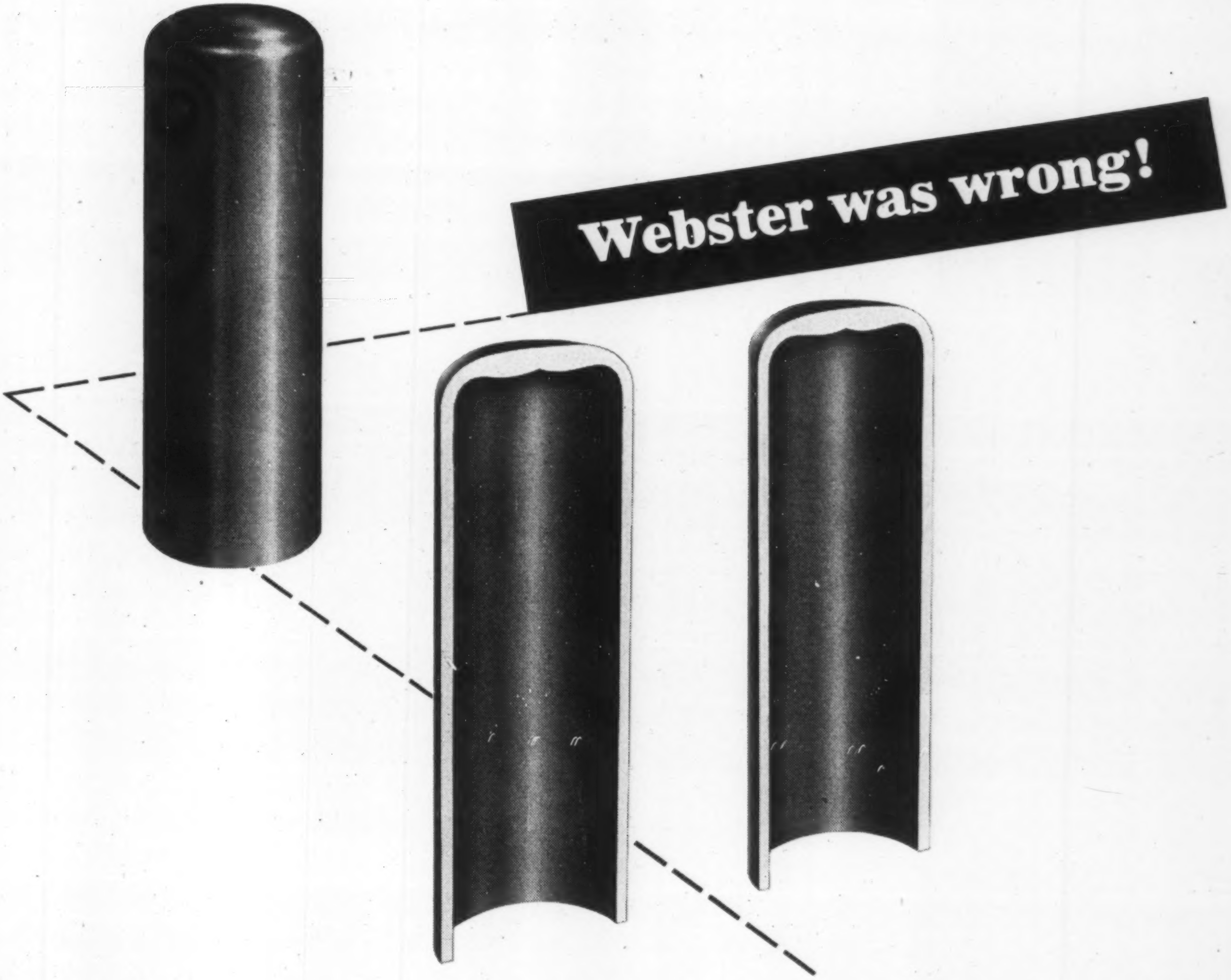
Schatz "Commercials" cover the complete range of standard types and sizes ...are all alike in their low-cost, multipurpose advantages. Fifty years of ball bearing specialization have seen to that.

Write "Schatz—Commercials" into *your* specs...then compare their on-the-job performance.

THE SCHATZ MANUFACTURING COMPANY
POUGHKEEPSIE, NEW YORK
REPRESENTATIVES LOCATED AT
Detroit . . . . 2640 Book Tower—26
Chicago . . . . 8 S. Michigan Avenue—3
Cleveland . . . . 402 Swetland Building—15
Los Angeles . . . . . . 5410 Wilshire Boulevard—36

SCHATZ
"Commercial"
BALL BEARINGS

The low-cost, multi-purpose ball bearing


Webster was wrong!

WEBSTER defined tubing as "a length or piece of tube . . . a hollow cylinder for conveying fluids, etc." But several smart production executives can provide a much better definition of tubing: "A time-saving, cost-cutting aid to more efficient production."

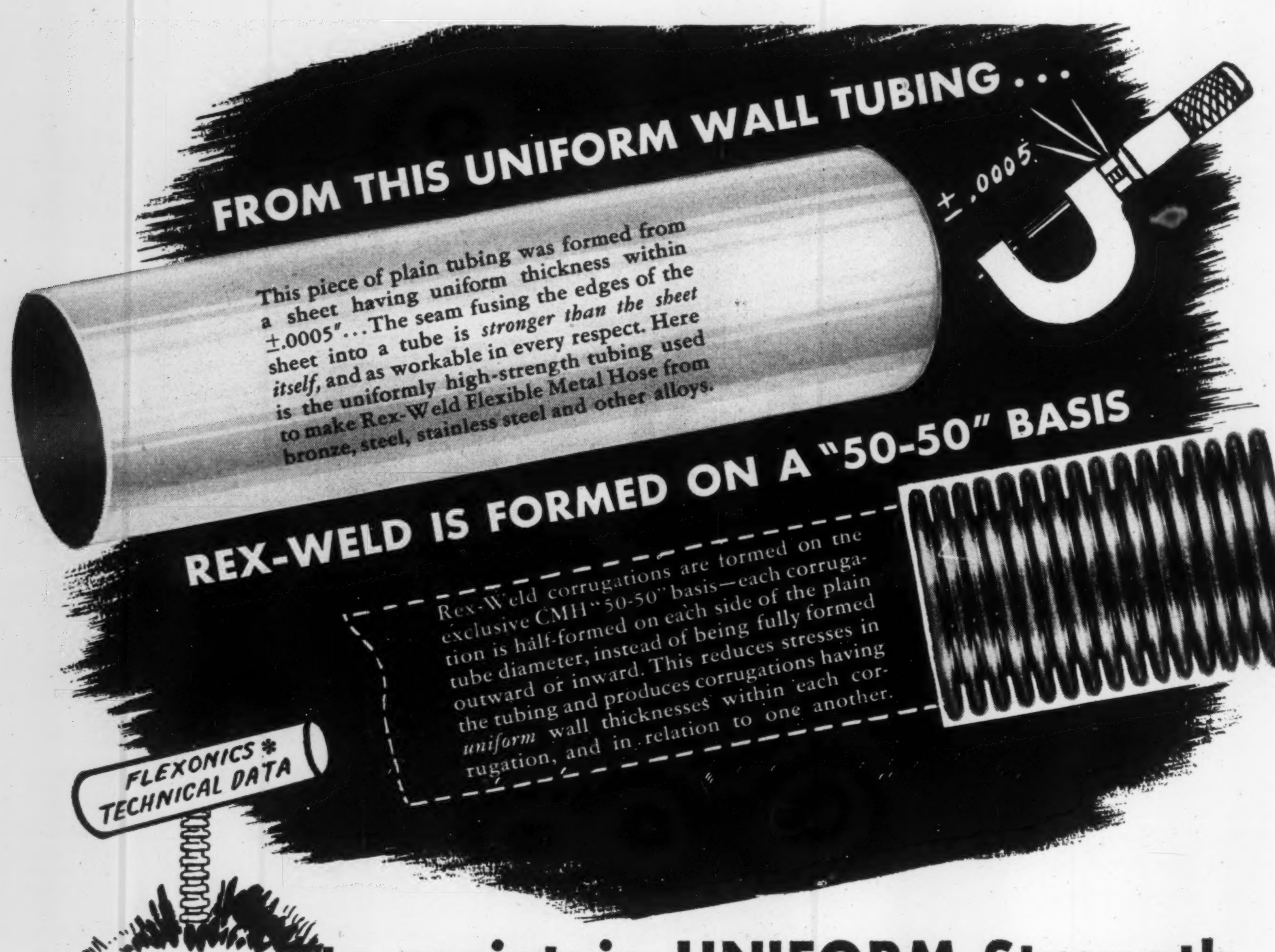
Of course, they're referring to OSTUCO seamless and electric-weld steel tubing, fabricated to the most intricate specifications by skilled OSTUCO craftsmen.

Spinning, the process illustrated, is just one of the many forming and fabricating operations OSTUCO is prepared to perform for you. This one process alone has cut production time and costs on such divergent products as dentist's drills and refrigerator compressors . . . it may be the solution to *your* production problem. An OSTUCO sales engineer will gladly show you how and why.

THE OHIO SEAMLESS TUBE COMPANY

***Plant and General Offices:* SHELBY, OHIO**

SALES OFFICES: CHICAGO, Civic Opera Bldg., 20 North Wacker Dr CLEVELAND, 1328 Citizens' Bldg. • DETROIT, 2857 E. Grand Blvd. HOUSTON, 927 A M & M Bldg. • LOS ANGELES, Suite 200-170 So. Beverly Drive, Beverly Hills • MOLINE, 309½—16th St. • NEW YORK, 70 East 45th St. • PHILADELPHIA, 1413 Packard Bldg., 15th & Chestnut • ST. LOUIS, 1230 North Main St. • SEATTLE, 3205 Smith Tower SYRACUSE, 501 Roberts Ave. CANADIAN REPRESENTATIVE: Railway & Power Corp., Ltd., HAMILTON, MONTREAL, NORANDA, NORTH BAY, TORONTO, VANCOUVER and WINNIPEG.


FROM THIS UNIFORM WALL TUBING . . .
±.0005
REX-WELD IS FORMED ON A "50-50" BASIS
FLEXONICS *
TECHNICAL DATA

This piece of plain tubing was formed from a sheet having uniform thickness within ±.0005"...The seam fusing the edges of the sheet into a tube is *stronger than the sheet itself*, and as workable in every respect. Here is the uniformly high-strength tubing used to make Rex-Weld Flexible Metal Hose from bronze, steel, stainless steel and other alloys.

Rex-Weld corrugations are formed on the exclusive CMH "50-50" basis—each corrugation is half-formed on each side of the plain tube diameter, instead of being fully formed outward or inward. This reduces stresses in the tubing and produces corrugations having *uniform* wall thicknesses within each corrugation, and in relation to one another.

to maintain UNIFORM Strength . . . in your FLEXIBLE METAL HOSE!

You can be sure that each type of Rex-Weld Flexible Metal Hose will give full service value within its rating because *there is no guesswork* in the construction of this multi-purpose hose . . . Every operation—from original design to final inspection—is performed within known factors of material strength and flexibility.

Uniformity of wall thickness in Rex-Weld hose allows exact evaluation of its service ability in your plant . . . There are no thin spots or undetected strains to bring early and unexpected failures in service . . . and the exclusive CMH method of forming corrugations provides full flexibility and high resistance to metal fatigue without weakening the basic tubing.

Full data on the many different types of Rex-Weld Flexible Metal Hose in sizes from 3/16" to 12" I. D. and lengths to fit your needs is available. Write for it today.

Some Plain Facts on Metal Tubing . . . Flexible and Otherwise

All CMH Rex-Weld Flexible Metal Hose is made from tubing formed out of flat strips of the various metals used, and is seam-welded at the strip edges to produce a tube of uniform strength, thickness and flexibility. There are a number of reasons for using this type of tubing as a basis for Rex-Weld; *but most important is that only in this way is it possible to be sure of uniform wall thickness in the finished product.* Other methods of manufacture cannot—as yet—hold tubing to nearly as close tolerances as the rolled strip from which Rex-Weld is made.

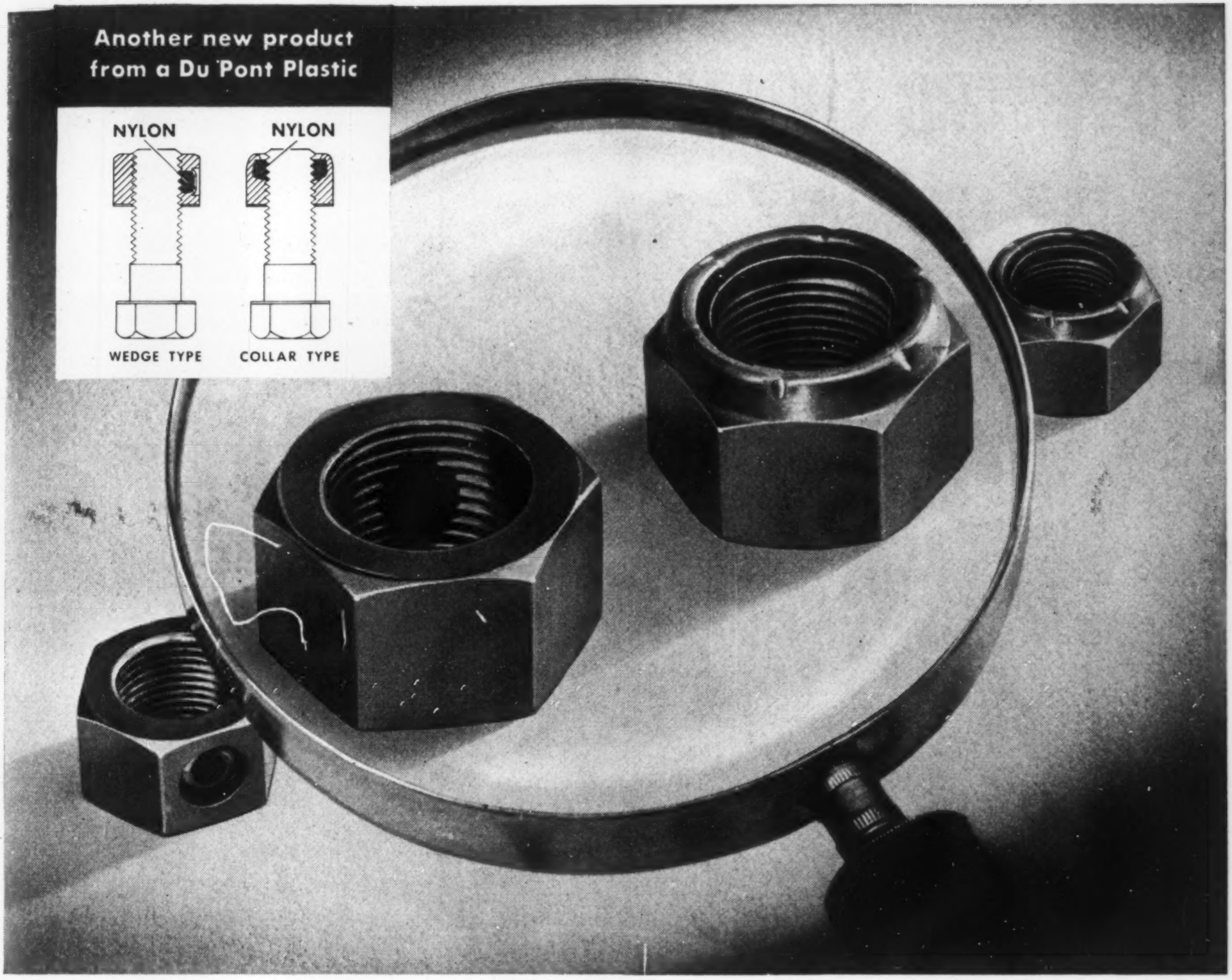
- Laboratory tests show that when Rex-Weld samples are subjected to abnormally elevated pressures, failure of the tubing occurs at undeterminable points anywhere in the tube.
- CMH choice of seam-welded strip is solely on the basis of findings of its superiority for use in top quality flexible metal hose.

*the science of **FLEXONICS** . . . "the controlled bending of thin metals for use under varying conditions of temperature, pressure, vibration and corrosion" . . . is exemplified in the basic products of Chicago Metal Hose Corporation.

"FLEXON" *identifies CMH products, which have served industry for more than 45 years.*

CMH

**CHICAGO METAL HOSE
CORPORATION**
Maywood, Illinois
Plants at Maywood and Elgin, Illinois



200 LOCKUPS CAN'T LICK 'EM

New safer lock-nuts made possible by Du Pont nylon

WHAT'S NEW

Here's sales-building eye-appeal for frozen foods. This crystal-clear cover of Du Pont "Lucite" protects and insulates while it displays foods stored within the cabinet. It's strong enough to support carelessly placed shopping bags . . . light and easy to open . . . dimensionally stable. And this design resists fogging. "Lucite" is economically and easily fabricated. (Frozen food cabinet manufactured by Fraser and Johnston Manufacturing Company, San Francisco, California.)

Here's something never achieved before . . . self-locking nuts that can be taken off when desired and used as many as 199 additional times or more without losing their firm grip!

They're made with a tough, resilient insert of molded Du Pont nylon. Severe vibrational stresses can't budge them... only a wrench will remove them. For a given size, the 200th removal requires a torque that is only a few inch-pounds under that of the first removal. There's no deterioration in storage . . . little or no loss of structural strength caused by loosened lock-nuts. Nylon resists oils, solvents, gasoline, and moisture—shows little or no effect with age. These lock-nuts are easily and economically adapted to mass production . . . assure dependable, long-lasting service and safety in the fastening of vital parts.

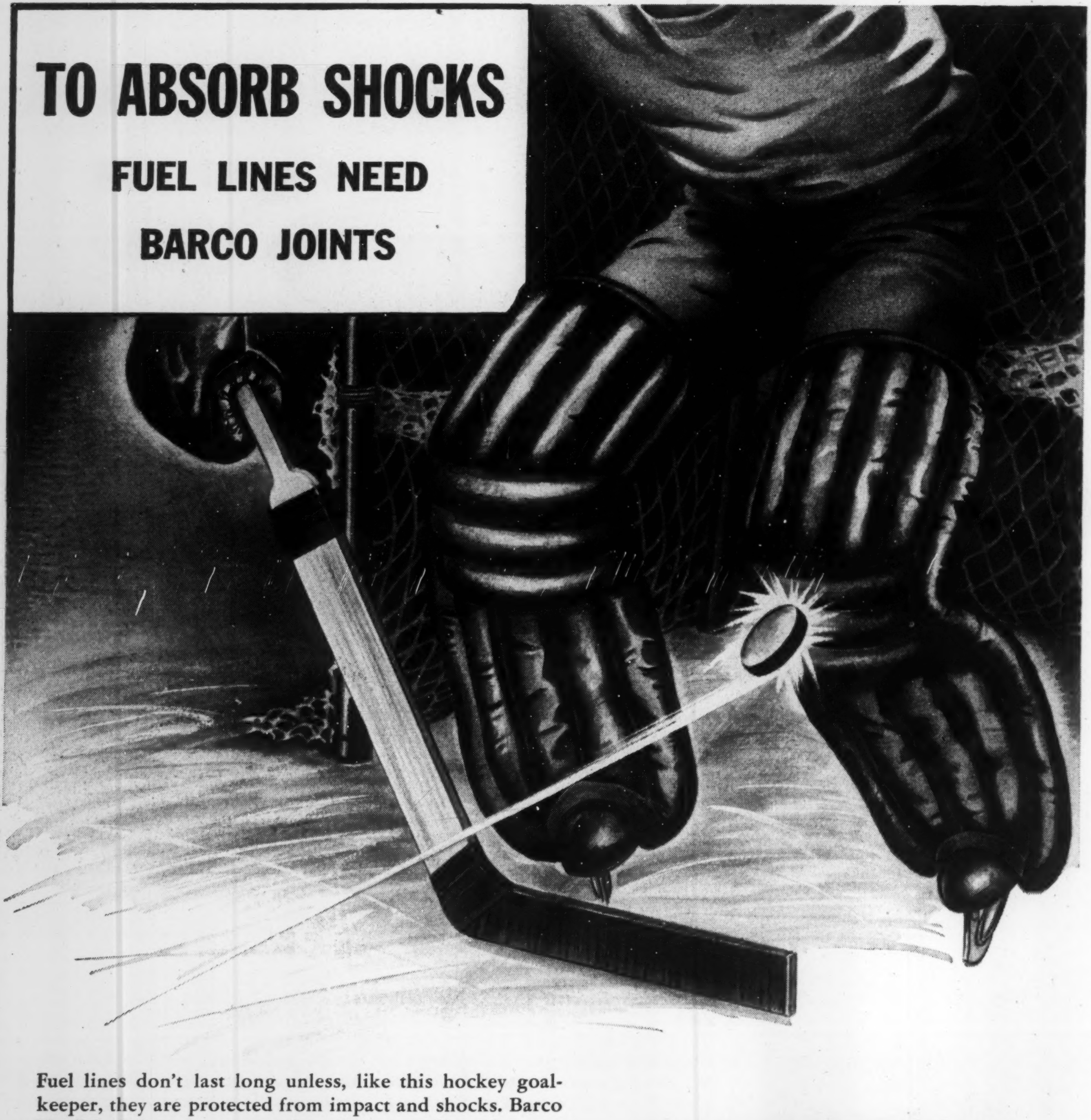
Study the properties of nylon . . . and other Du Pont plastics. Like this manufacturer, you may find a way to develop a new product . . . or a means of improving an old one. Write now for literature. It will pay you to have it in your files. E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Room 3912 Arlington, New Jersey.

Lock-nuts of various types with nylon inserts made by the Elastic Stop Nut Corp. of America, Union, N. J. and the Nylok Corp., 475 5th Ave., New York, N. Y

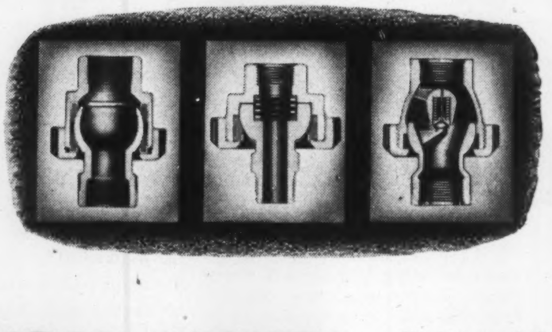
DU PONT
REG. U. S. PAT. OFF
Plastics
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

TO ABSORB SHOCKS

FUEL LINES NEED BARCO JOINTS



Fuel lines don't last long unless, like this hockey goalkeeper, they are protected from impact and shocks. Barco Flexible Joints, by responsive movement through every angle, absorb shocks and stresses in fuel lines, compensate for expansion and contraction. For over 30 years, these valuable time and cost savers have been guarding fluid-conveying systems from the deadly effects of vibration, preventing leakage and fractures. Whatever your special installation may be, you'll find the right joint for it in the Barco line. Write for complete facts. Barco Manufacturing Company, Not Inc., 1806 Winnemac Avenue, Chicago 40, Illinois. In Canada: The Holden Co., Ltd., Montreal, Can.

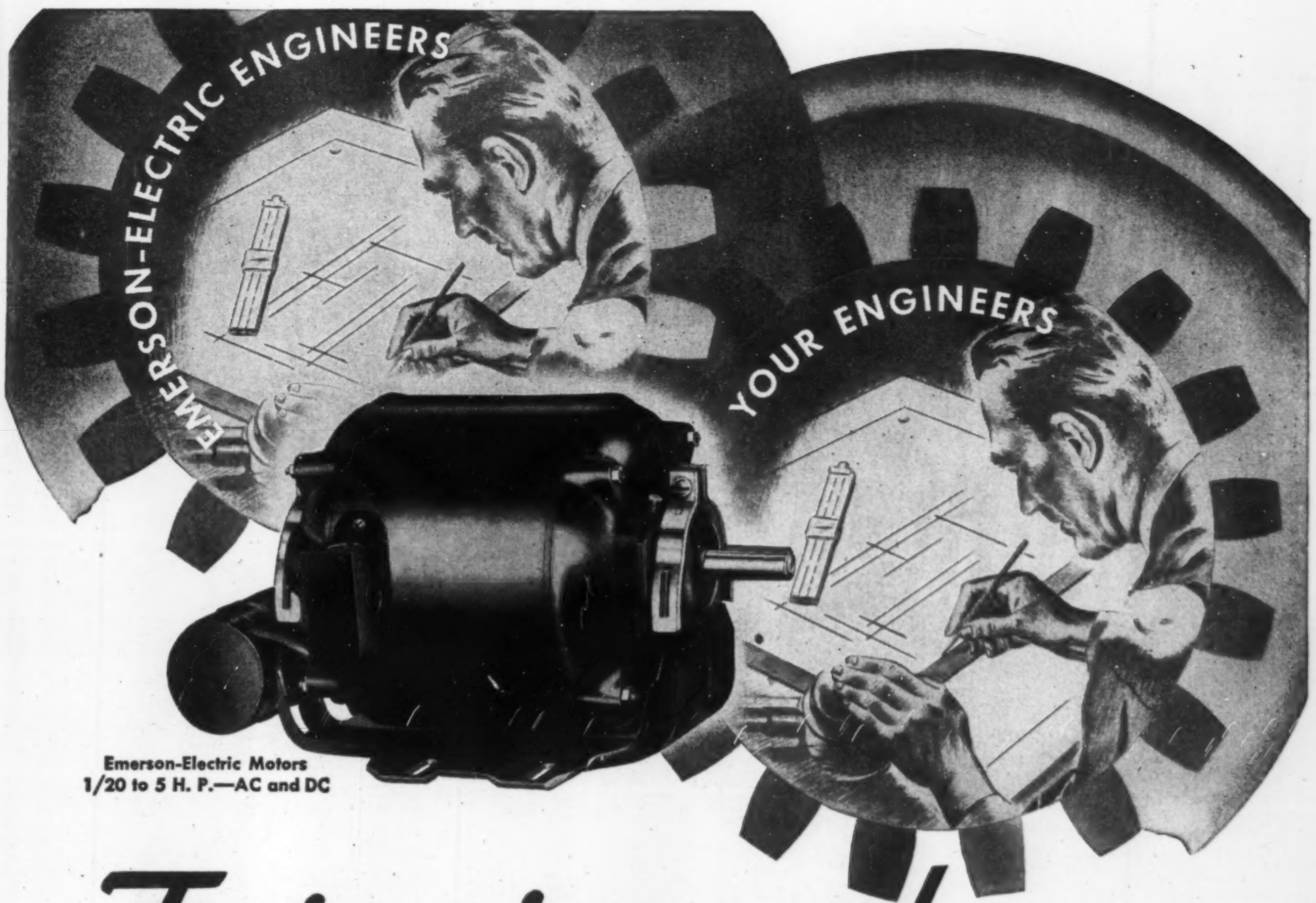


BARCO FLEXIBLE JOINTS

FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

Not just a swivel joint …but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.

"MOVE IN EVERY DIRECTION"



Emerson-Electric Motors
1/20 to 5 H. P.—AC and DC

Twin-gineered

...TO MESH WITH YOUR PRODUCT

THE *right* kind of power for the *right* kind of product can be accomplished by "meshing" our effort with yours.

When *your* engineers collaborate with *Emerson-Electric* engineers three things may happen . . :

- You save costly engineering back-tracking and obtain the most efficient type of motor for each application.
- You effect production savings through the most practical application of the power unit.
- Your new product reaches the market properly equipped to provide the competitive edge so necessary for profitable merchandising.

If you are planning a new or improved motor-driven appliance, take advantage of Emerson-Electric's 57 years of engineering experience. Such collaboration—"Twin-gineering," we call it—is yours for the asking.

Suggest to your Chief Engineer that he "Call in Emerson-Electric." Write TODAY.

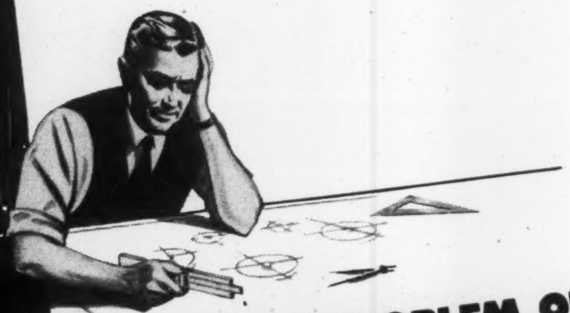
THE EMERSON ELECTRIC MFG. CO.
St. Louis 21, Mo.

Branches: New York, Chicago, Cincinnati, Detroit, Los Angeles and Davenport
55

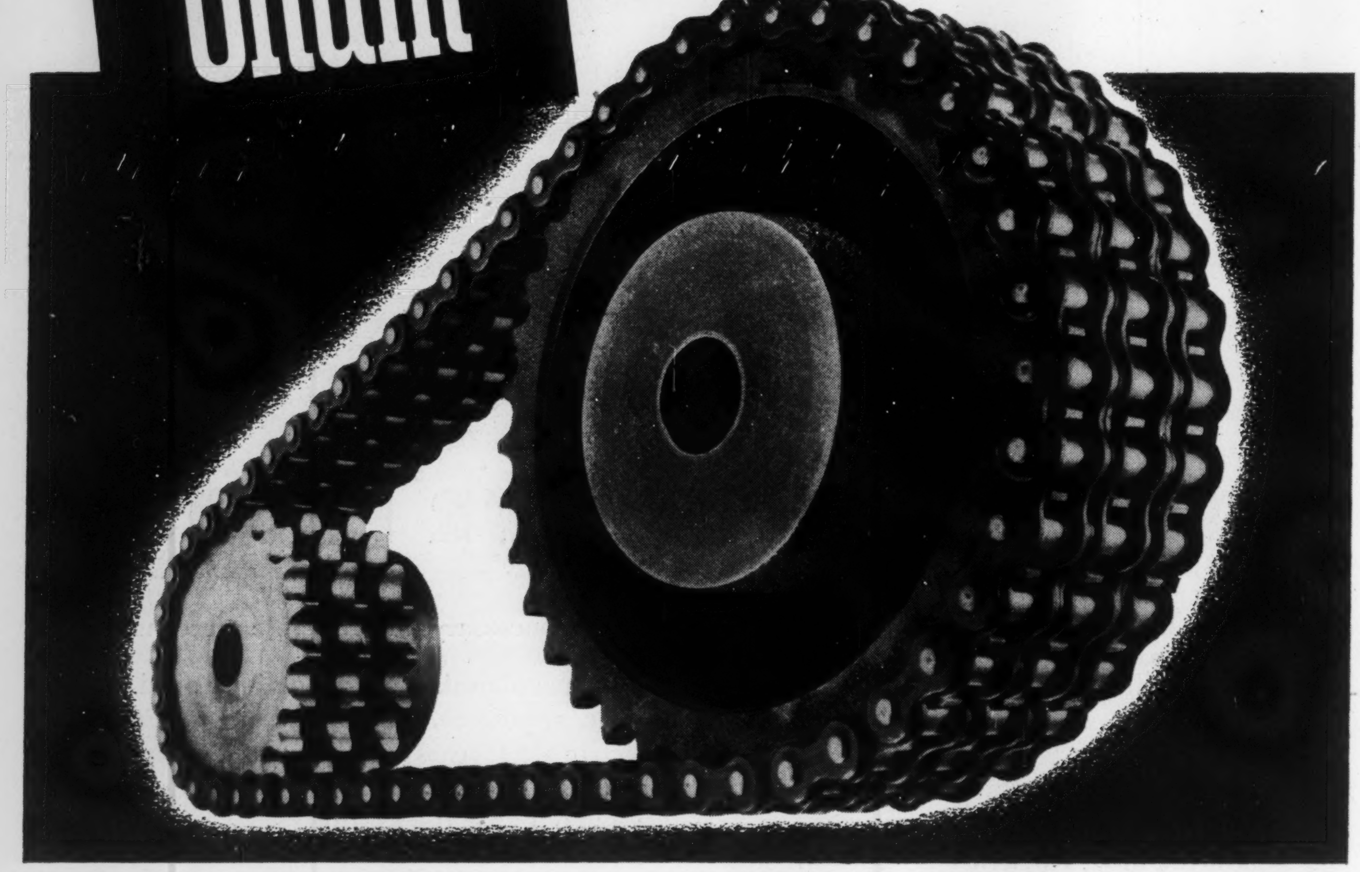
EMERSON EMERSON ELECTRIC **ELECTRIC**

MOTORS · FANS APPLIANCES

Whitney Chain



TAKES THE PROBLEM OUT OF YOUR POWER DRIVE DESIGNS



Got a special drive problem . . . one that is giving you real trouble? If so, stop and consider what Whitney can offer you.

Because Whitney Chains are extremely flexible and adaptable to a wide range of designs, they simplify power transmission designs. In addition, the wide range of selection makes application easy.

Whitney Chain Drives...roller, silent or conveyor...provide *positive grip* assuring highest transmission efficiency. They transmit constant motor speed without slippage or friction loss. Whitney Chain drives are easy to install, easy to remove without disconnecting shafts. They do not need frequent adjustments to maintain tension. Their rugged construction and hardened alloy-steel parts assure maximum service with minimum maintenance.

Look into Whitney Chains and cut tooth sprockets . . . *the all-steel drives* for your designs. Write for information today.

P.S. You will be most welcome at our booth #539 at the 2nd National Materials Handling Exposition, Cleveland, Ohio.

The
Whitney
Chain & Mfg. Co.
HARTFORD 2, CONN.

Answering the Question thousands have been asking....

CASTELL
DRAWING PENCIL
the finest the world has ever known ..representing 186 years of priceless experience
A.W.FABER "CASTELL" U.S.A 9000 HB
is back!

Yes, CASTELL is back.

Since 1761 the little town of Stein, in Bavaria, has been the world center of pencil craftsmanship.

And now the incomparable Bavarian Craftsmen are again compounding and milling CASTELL graphite according to the original secret micrometric process of the world-renowned House of A. W. Faber.

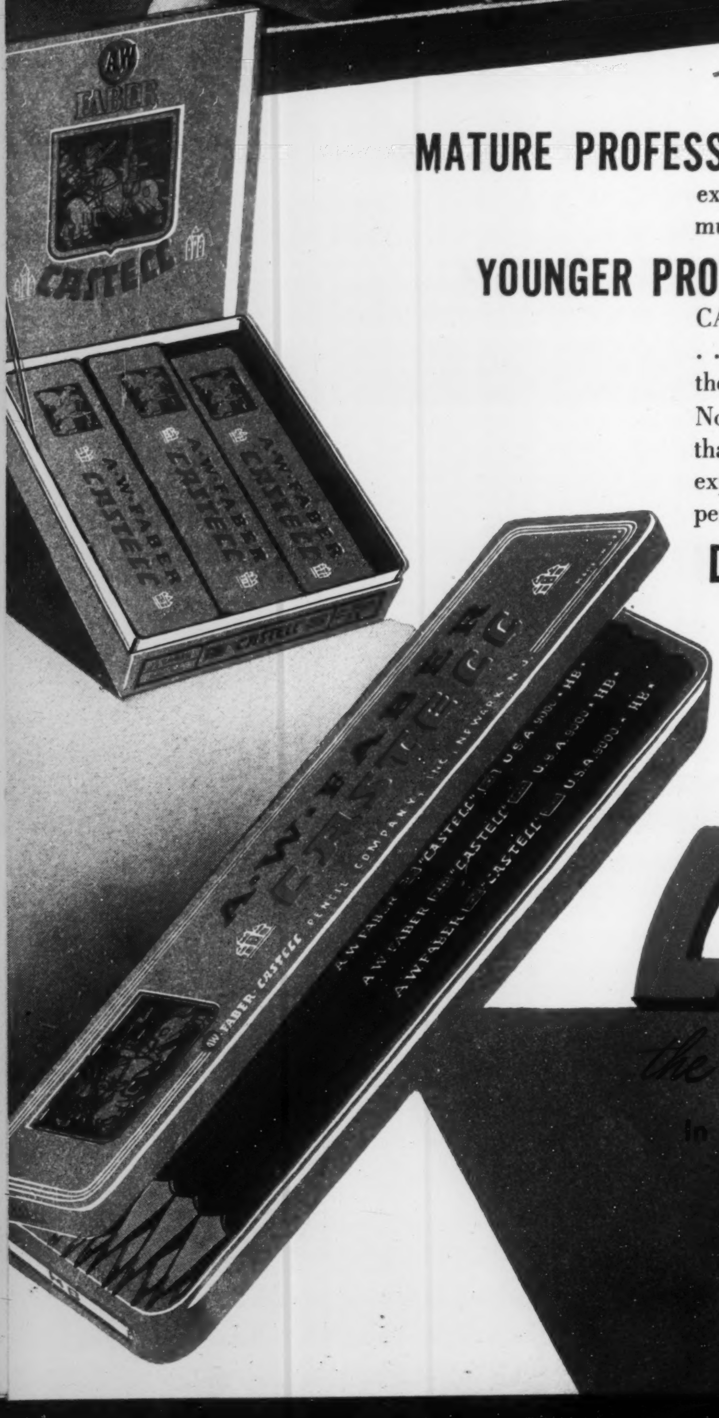
CASTELL, the standard by which all other pencils are judged . . . unbelievably smooth, grit-free, easily-sharpened, uniformly graded CASTELL . . . is now being imported with the sanction and approval of the U. S. Military Government in Bavaria.

In our own country American production genius teams up with inimitable old-world skill. Here this unexcelled CASTELL graphite is encased in choice, nature-seasoned aromatic Southern cedar—each pencil stamped in gold with the certification of original CASTELL quality, the favorite of American Professional Men for generations . . .

the Drawing Pencil of the Masters

A.W. FABER-CASTELL
PENCIL COMPANY INC. NEWARK 4 N.J.

A.W.FABER "CASTELL" U.S.A. 9000 * HB *


A.W. FABER
CASTELL
A.W. FABER CASTELL
A.W. FABER CASTELL PENCIL COMPANY INC NEWARK N.J.
A.W. FABER "CASTELL" U.S.A. 9000 HB

MATURE PROFESSIONAL MEN... you who depended on the undeviating excellence of CASTELL year after year . . . we know how you must thrill to the dramatic news—"CASTELL is back!"

YOUNGER PROFESSIONAL MEN... you who heard echoes of CASTELL'S fame in the wistful conversation of your seniors . . . now *you* will be privileged to use the Drawing Pencil of the Masters.

Now you will know the singular satisfaction of using a pencil that translates gray matter into black, that gives free-flowing expression to robust ideas with a rich, graphic opacity no other pencil in the world can match.

DEALERS... We of the House of A. W. Faber-Castell thank you for your patience. This is a proud announcement for us as it must be a great day for you. Thousands of your customers engaged in the arts, the professions and in business—artists, architects, engineers, designers, draftsmen and executives—are waiting for

CASTELL

the Drawing Pencil of the Masters

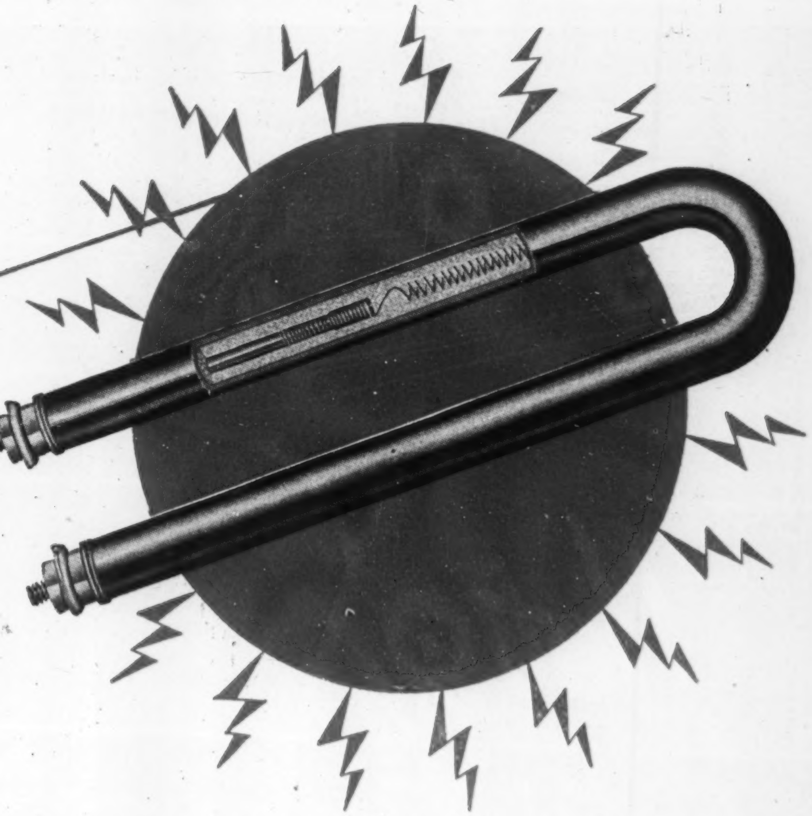
In 18 matchless degrees of black . . . . 7B to 9H

15¢ each . . . less in quantities

WRITE, WIRE OR TELEPHONE

A.W. FABER-CASTELL
PENCIL COMPANY INC NEWARK 4 N.J.

YALE Hottest News In Electric Heat!



Now YALE . . . famous for its locks and materials handling equipment ... gives you an enclosed electric heating element that you *know* will give *uniform* heat.

That's the word we want you to associate in your mind with YALE—*uniform.* We're putting into this heating element the same craftsmanship that made "YALE" the No. 1 name in locks . . . in order to make "YALE" the No. 1 name in *electric heat.* For example, YALE's famous manufacturing controls result in:

1. uniform distribution of the refractory within the sheath for *uniform insulation*

2. accurately centralized location of the resistor—equidistant from the sheath throughout its length — for *uniform heat transfer*

We are now in production at our Buffalo plant on the first of a complete line of electric heating units. You can get immediate shipment on the YALE *Electric* Rod-Type Heating Unit.

TRADE YALE MARK

Makers of the famous YALE lines of Locks, Hardware, Door Closers, Hoists and Industrial Trucks.

YALE *Electric* UNIFORM HEAT

THE BRIGHT SPOT IN ELECTRIC HEATING

THE YALE & TOWNE MANUFACTURING COMPANY
YALE *Electric* HEATING UNIT SALES
Room 1035, Chrysler Building, New York 17, New York • MUrray Hill 9-6700

Please use this coupon to get further information.
Also describe your application in space below.

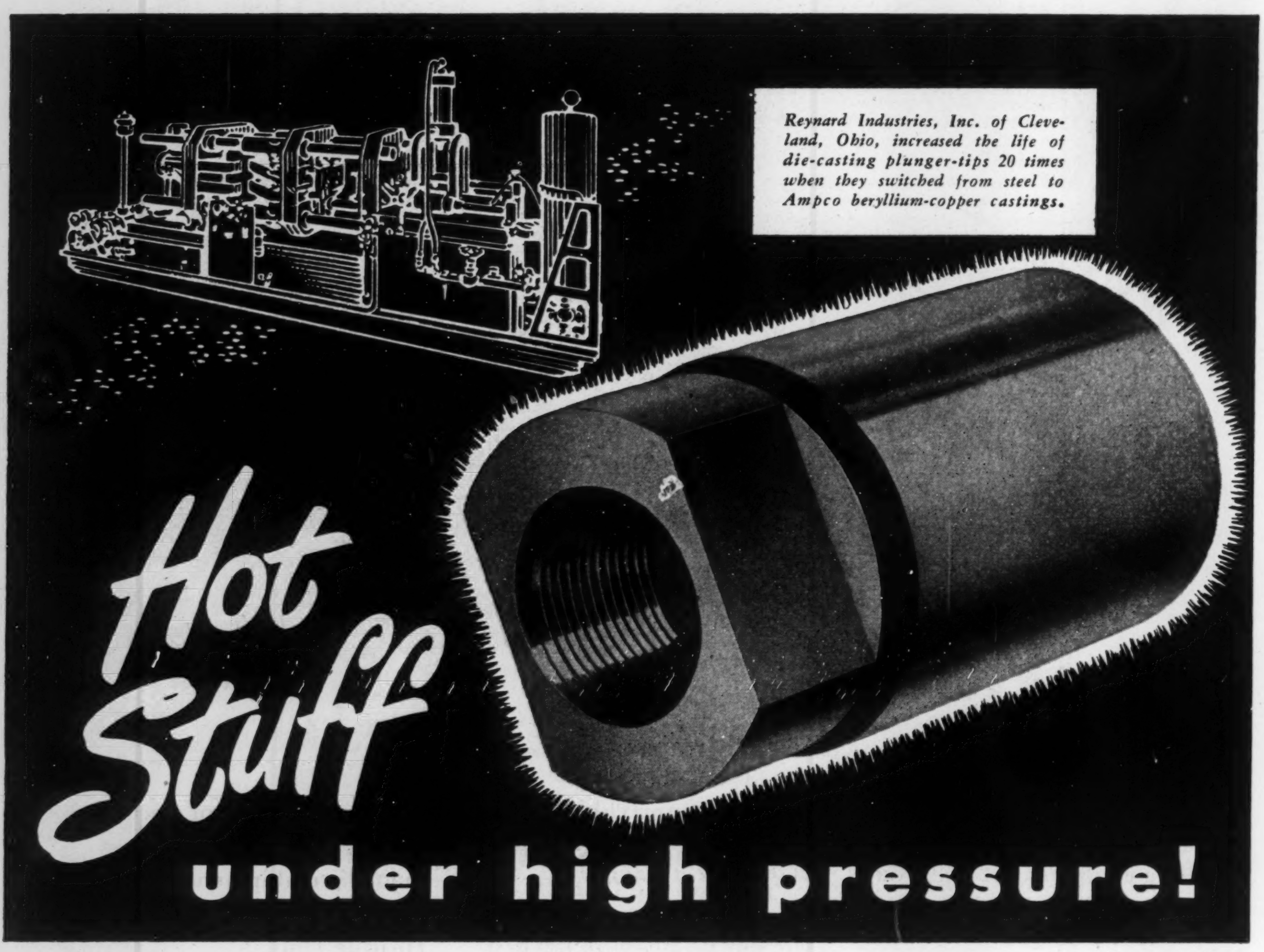
NAME__________

TITLE__________

COMPANY__________

ADDRESS__________

CITY__________ ZONE______ STATE______



Reynard Industries, Inc. of Cleveland, Ohio, increased the life of die-casting plunger-tips 20 times when they switched from steel to Ampco beryllium-copper castings.

Ampcoloy machine part outwears steel 20 times — drastically reduces maintenance and down time

Working against molten metal under high pressure is a tough job for any machine part. It's a job that wore out hardened steel plunger-tips in a die-casting machine every four or five days. But when Reynard Industries, Inc. specified wear-resistant Ampcoloy tips — they increased part life 20 times, prevented seizure and galling of cylinder wells (and the frequent honing previously required), and eliminated expensive graphitic lubrication which often discolored and spoiled castings.

This is a typical example of advantages you gain from wear-resistant Ampcoloys and Ampco Metal, the modern aluminum bronze. Use durable Ampco bronze parts in your own products as a selling feature. Look for them in equipment as a mark of quality when you buy. And replace worn parts in your present machines with Ampco alloys to reduce replacement frequency and slash maintenance costs.

Order Ampco Metal and Ampcoloys in centrifugal- and sand-castings, extrusions or forgings, according to your requirements. Let your nearby Ampco engineer help you select the proper grade for your needs. For more information about Ampco Metal and Ampcoloys, write for bulletins today!

Ampco Metal has 7 outstanding performance advantages—

Excellent bearing qualities • High strength-weight ratio • High compressive strength • High impact and fatigue values • Corrosion resistance • Wear resistance • Efficiency at extreme temperatures.

REG. U. S. PAT OFF.

AMPCO

Ampco Metal, Inc.
Dept. MD-12 • Milwaukee 4, Wis.
Field Offices in Principal Cities

AD-33

The NEW
GEARGRIND

GEARGRIND
DETROIT USA

Takes up to 24" between centers and work up to 10" dia.

With Automatic Wheel Feed

Work reciprocates past the grinding wheel, using a fast, short stroke. At each reversal point the grinding wheel feeds down, automatically.

Grinding continues on one tooth space until a "rough size" is reached, after which the work is indexed and the grinding wheel head re-set.

After a pre-set number of teeth have been "roughed out" the dresser moves into position for trueing the grinding wheel.

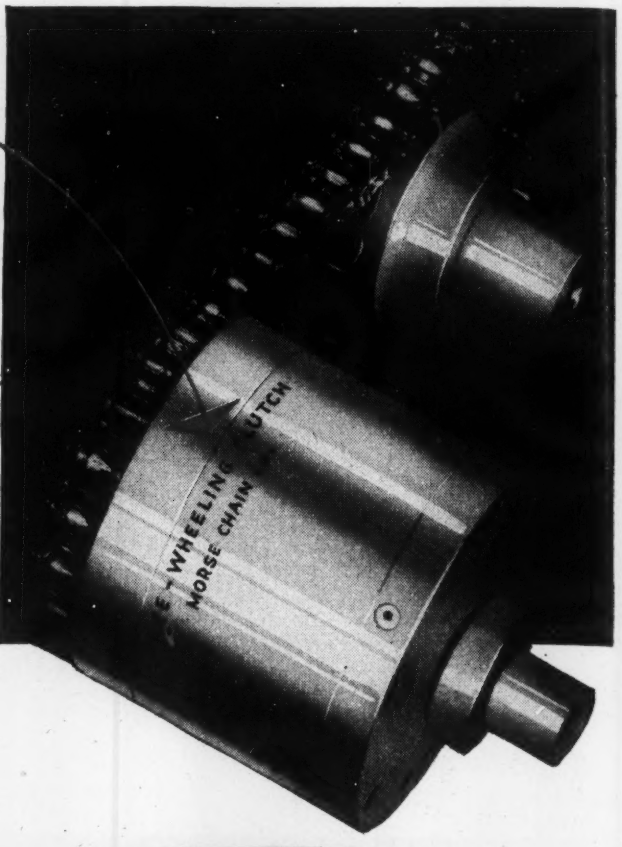
All these operations are automatic, and adjustments for number of teeth ground before dressing, total down feed and number of cuts is readily variable over a wide range.

Grinding by this new GEARGRIND method is done in ⅓ to ¼ of the time required by any previous gear grinding machine of comparable capacity.

***WRITE** for complete information.*

The GEAR GRINDING
MACHINE COMPANY
DETROIT 11, MICH., U.S.A.

ON THE JOB



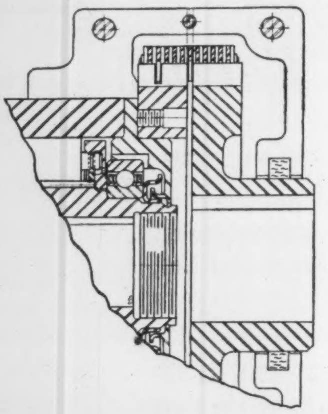
A MORSE FREE-WHEELING CLUTCH AT WORK

The Caspers Tin Plate Company of Chicago, tin plate lithographers, use a Morse free-wheeling clutch and a Morse Roller Chain as the heart of their auxiliary oven drive. Normally the printing press motor drives both press and oven-conveyor while the clutch free-wheels. When the press is shut down, the clutch engages the auxiliary drive, operating the oven-conveyor line independently.

3 MORE WAYS MORSE CLUTCHES WORK FOR YOU

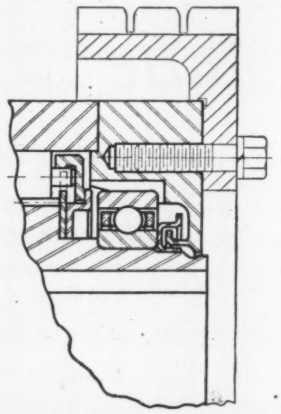
WITH

SILENT CHAIN COUPLINGS



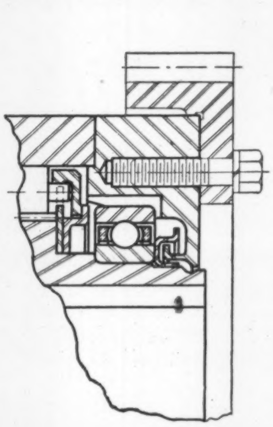
For direct, endwise drive applications on pumps, induction and forced draft fans.

SILENT CHAIN DRIVES



For positive indexing of feed rolls on punching, forming and shearing presses.

GEAR DRIVES



For backstop control on conveyors, spring coilers, paper mills, hoists.

MORSE clutches, couplings, roller and silent chain drives are adaptable to many applications of value to you. *Put them on the job!*
MORSE CHAIN COMPANY • DETROIT 9, MICHIGAN

Consult Our Engineers

MORSE

MECHANICAL POWER TRANSMISSION PRODUCTS

A PRODUCT OF
B-W
BORG-WARNER

Brandt Can Help You Solve Your Specialized Metal Working Problem

STAMPINGS • WELDMENTS

ranging from many tons to but a few ounces

Don't let problems involving time, special facilities, extra space and equipment, precise know-how and the like be stumbling blocks in the production of your metal working job. Brandt has the complete solution to all these problems . . . . and many more. 150,000 sq. ft. of special mass production facilities stand behind an impressive record in the service of many exacting customers. Brandt welcomes your inquiry regarding

STAMPINGS **HEAVY WELDMENTS** **FORMING**

SPOT WELDED ASSEMBLIES, PLATE FABRICATION, CRATING & SHIPPING FACILITIES, COMPLETE ASSEMBLIES.

IN ALL TYPES OF METALS

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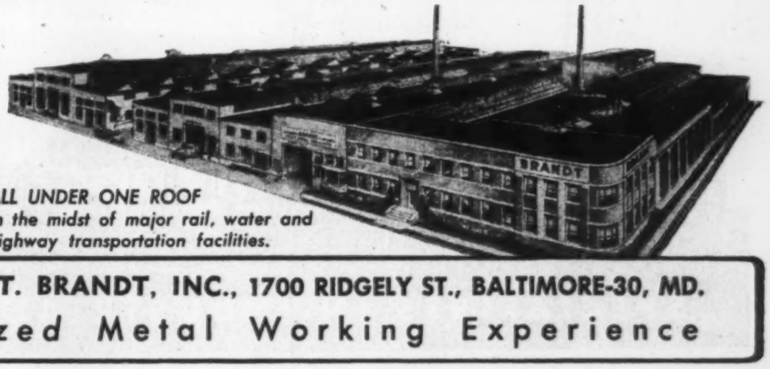

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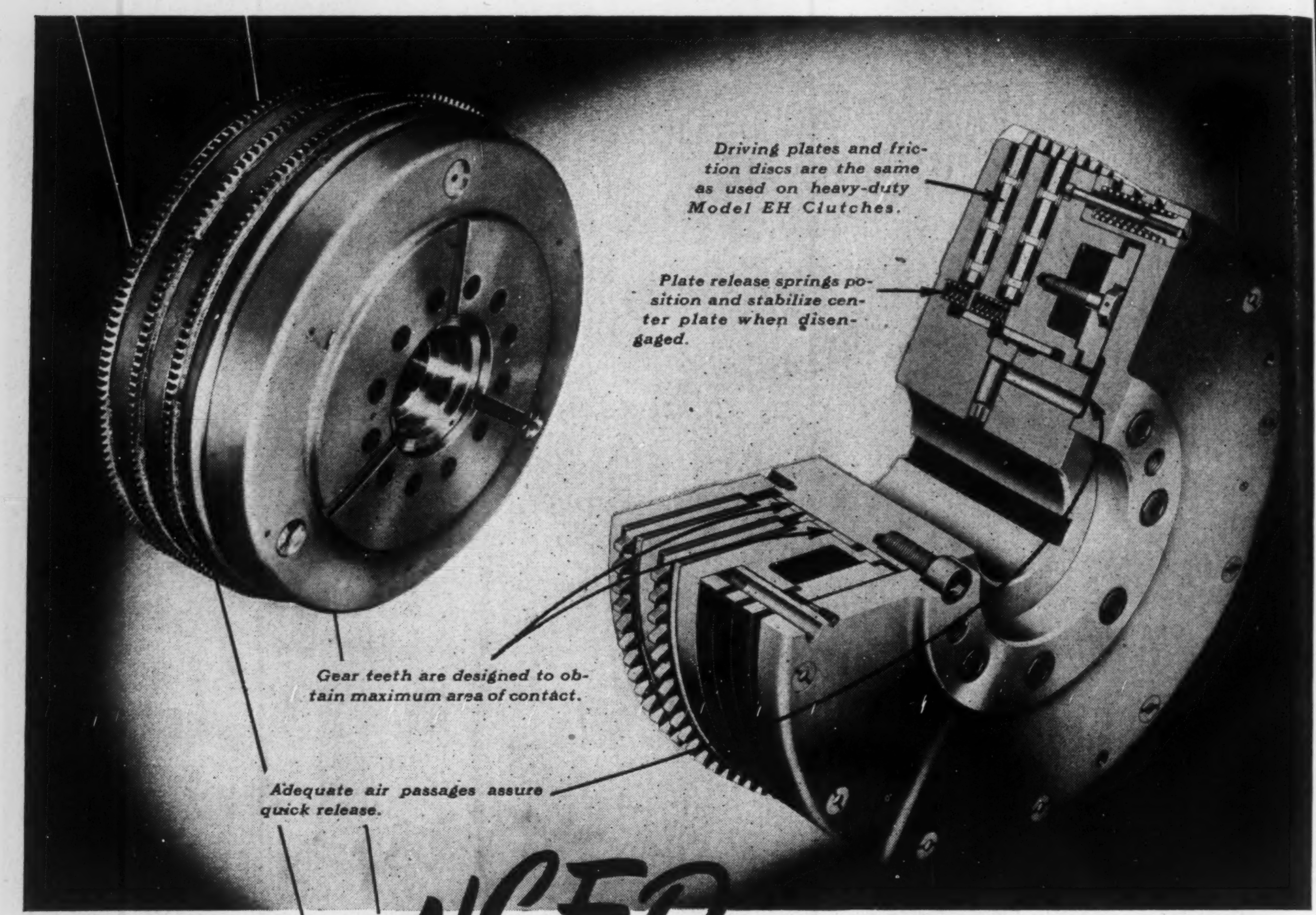
Driving plates and friction discs are the same as used on heavy-duty Model EH Clutches.
Plate release springs position and stabilize center plate when disengaged.
Gear teeth are designed to obtain maximum area of contact.
Adequate air passages assure quick release.

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Experience has proved the mechanical proportions of the Twin Disc Models P and PH Air-actuated Clutches to be in proper balance for efficient work, for long wear-life, and to absorb and dissipate heat . . . essential qualities in heavy-duty clutch installations.

Twin Disc Air-actuated Clutches also permit operation by remote control without complicated linkage systems. They require less shaft space, thereby permitting closer shaft bearing center distances. Gear teeth are designed to obtain maximum area of contact. Multiple springs assure quick release and equal distribution of release pressure. Properly installed, these Clutches require no adjustments to maintain the correct pressure on the friction discs . . . an important factor in obtaining longer wear-life. Model P and PH Clutches are available in sizes from 14 to 42″, capacities from 75 up to 1325 hp.

If you have a heavy-duty clutch application requiring operation by remote control, write the Twin Disc Clutch Company for their engineers' recommendations. Ask for Bulletin No. 139-A. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).

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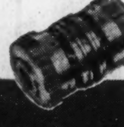
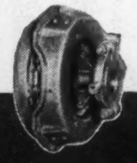

Machine Tool Clutch


Tractor Clutch

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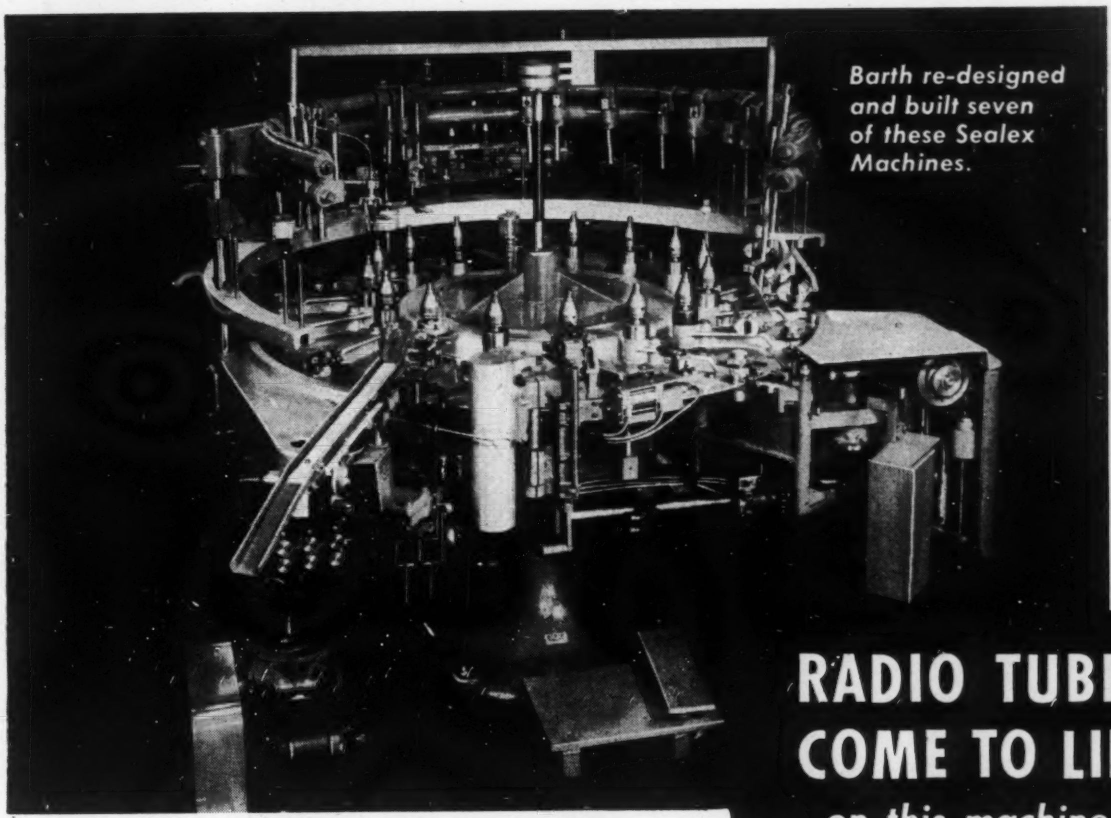
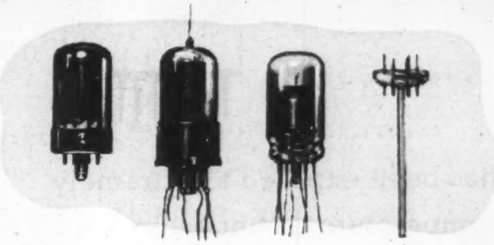


RADIO TUBES COME TO LIFE

on this machine!



★ VACUUMIZES THE TUBE

★ FUSES AND SEALS THE TUBE

★ NEUTRALIZES REMAINING GASES

THE MULTIPLICITY OF OPERATIONS performed on the Sealex Machine represents an accomplishment for which the radio tube industry deserves considerable credit . . . these machines have contributed substantially to the lower cost, improved performance and longer life of radio tubes.

From the time the operator feeds the unsealed tube parts to the Sealex Machine, the assembly passes through thirty-two stations which progressively fuses the two tube parts together . . . burns off and melts the glass, assuring an air-tight vacuum . . . activates a pellet inside the tube which silvers the tube and absorbs any gases remaining in the tube after it has been vacuumized.

There are sixteen rotary inner and sixteen stationary outer stations . . . several stations apply induction heat . . . others contact the lead wires to light up the tube . . . other stations employ gas burners.

Barth's vision and ability to help industry improve not only its products but also its speed of production and assembly, as well as Barth's complete tooling and special machinery designing and building facilities, are available to you. *Write for Barth's latest catalogue.*

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Denison at W. 34th St., Cleveland 9, Ohio

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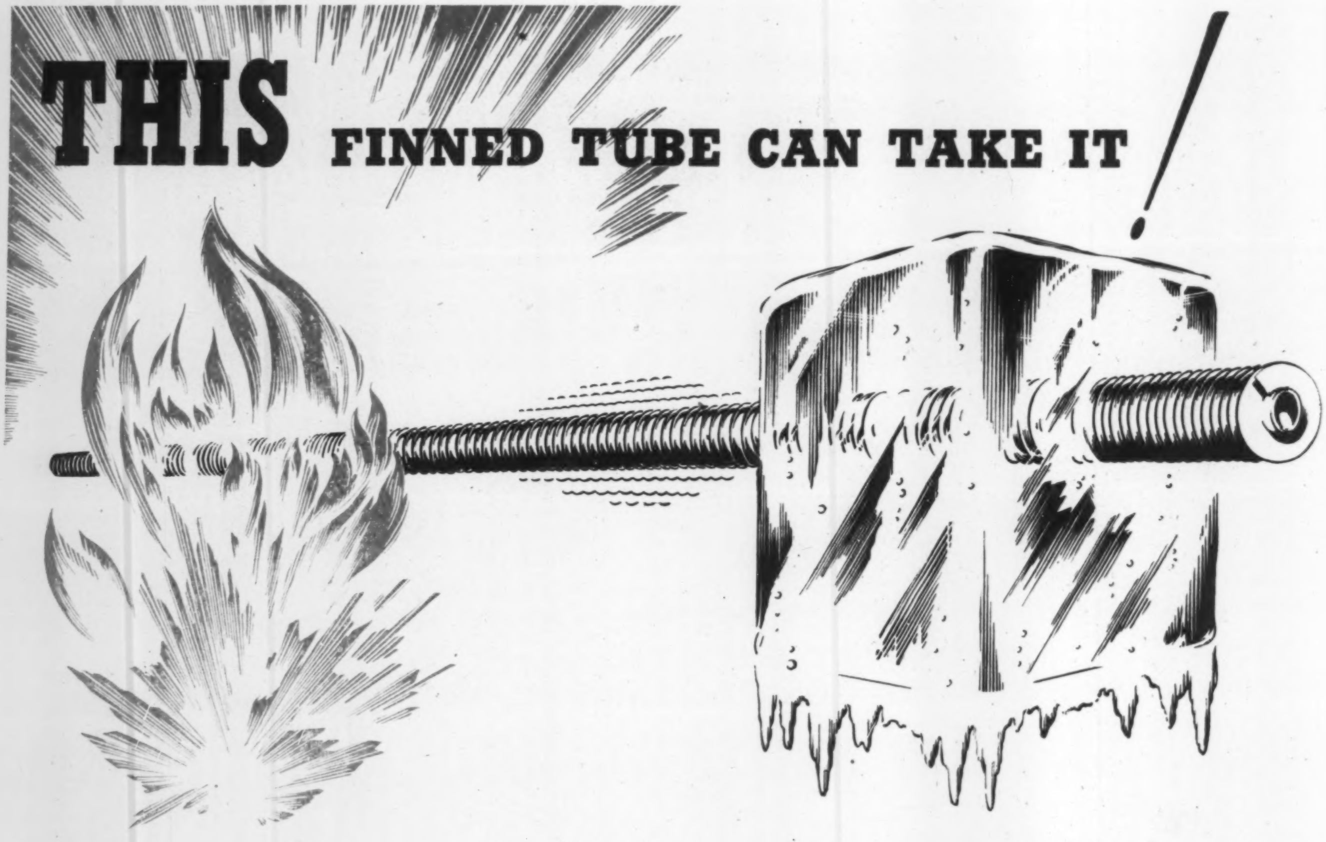
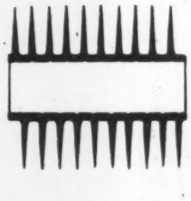

THIS FINNED TUBE CAN TAKE IT!

.....because the fins are integral with the tube itself!



Time and time again Wolverine Trufin has been exposed to extremely high heat. It has withstood sudden temperature changes in heat exchangers. It has operated efficiently under all kinds of vibration. In every case it has "taken it like a champ"– ready for more.

Designers, engineers, production men who know it, specify it. They recognize the economy its use represents in the "extra performance" it delivers – all because the fins are a part of the tube itself. Heat transfer is quick and sure. Trufin is unaffected by vibration.

If you don't know about Trufin, better ask us to send you some charts and other technical information.

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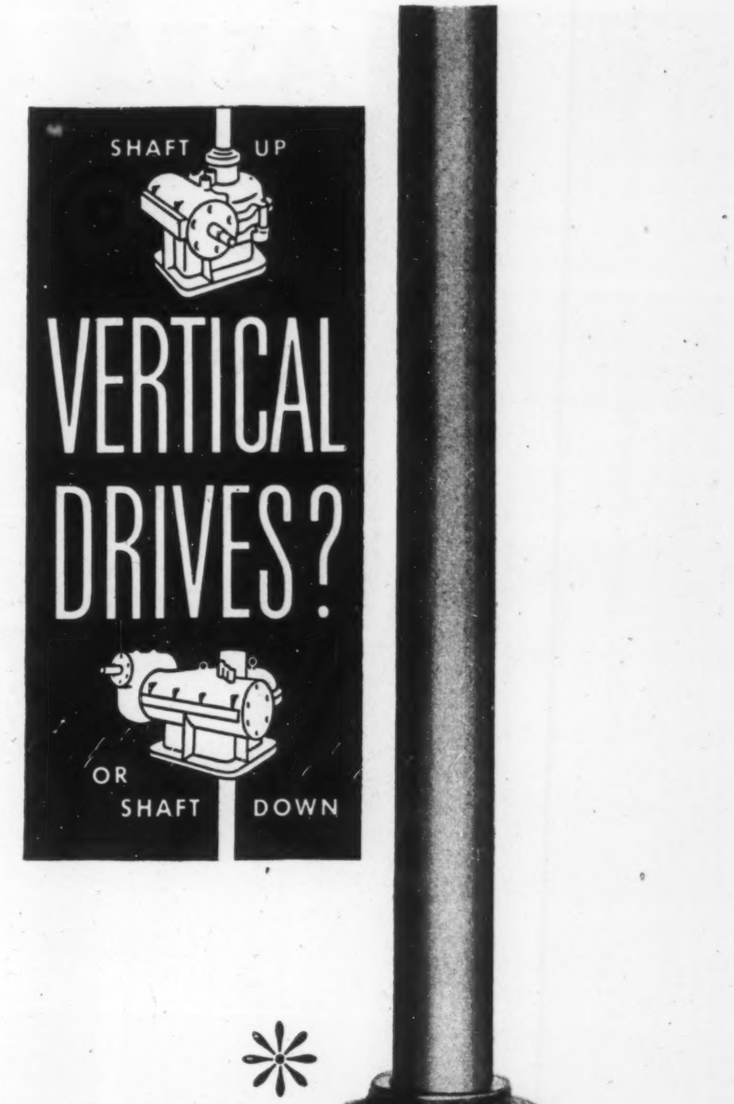

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A complete line of De Laval vertical speed reducers, in both single and double reductions, is available for driving agitators, mixers, and many other types of vertical shaft equipment.

If vertical drives are your problem, consult De Laval.

* This single reduction De Laval Worm Gear Reducer is available with many standard gear ratios and is but one of the 93 sizes of standard De Laval Worm Gear Speed Reducers.

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DE LAVAL

WG-16

***Worm Gear Division*, De Laval Steam Turbine Company, Trenton 2, New Jersey**

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS AND COMPRESSORS • IMO OIL PUMPS

ASCO SOLENOID VALVES

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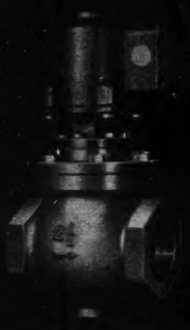
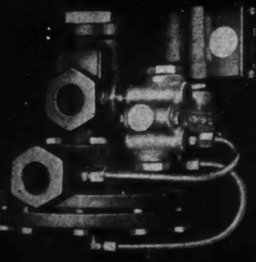
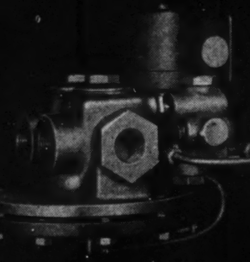
Must the flow be automatically controlled, with or without Cycling?


Packless Solenoid Valve


3-Way Solenoid Valve


4-Way Solenoid Valve

If your answer is "Yes", we suggest you get all the information about ASCO Solenoid Operated Valves. They're designed to do just this sort of work and if the destination of the machine is to be a "hazardous location" or if the liquid or gas handled is flammable or explosive, we have a very extensive line of "explosion-proof" valves.

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Automatic Switch Co.

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Photomicrograph (750x) of a copper-lead alloy particle. The copper is light, the lead dark.

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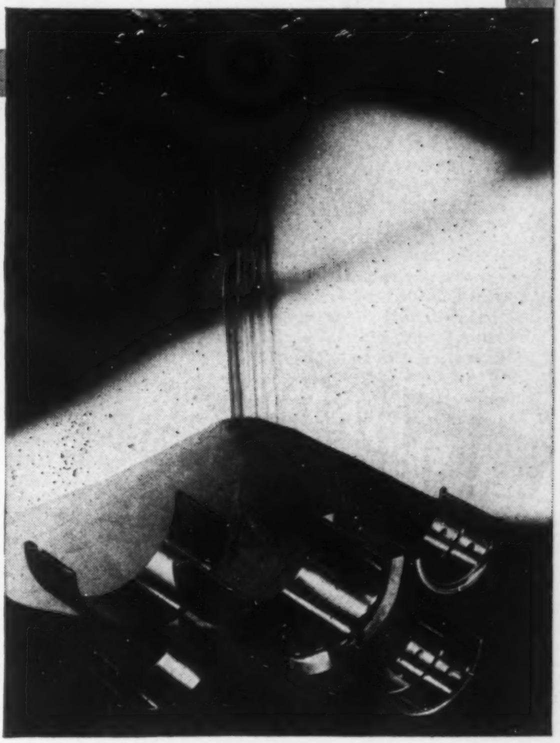

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4-WAY

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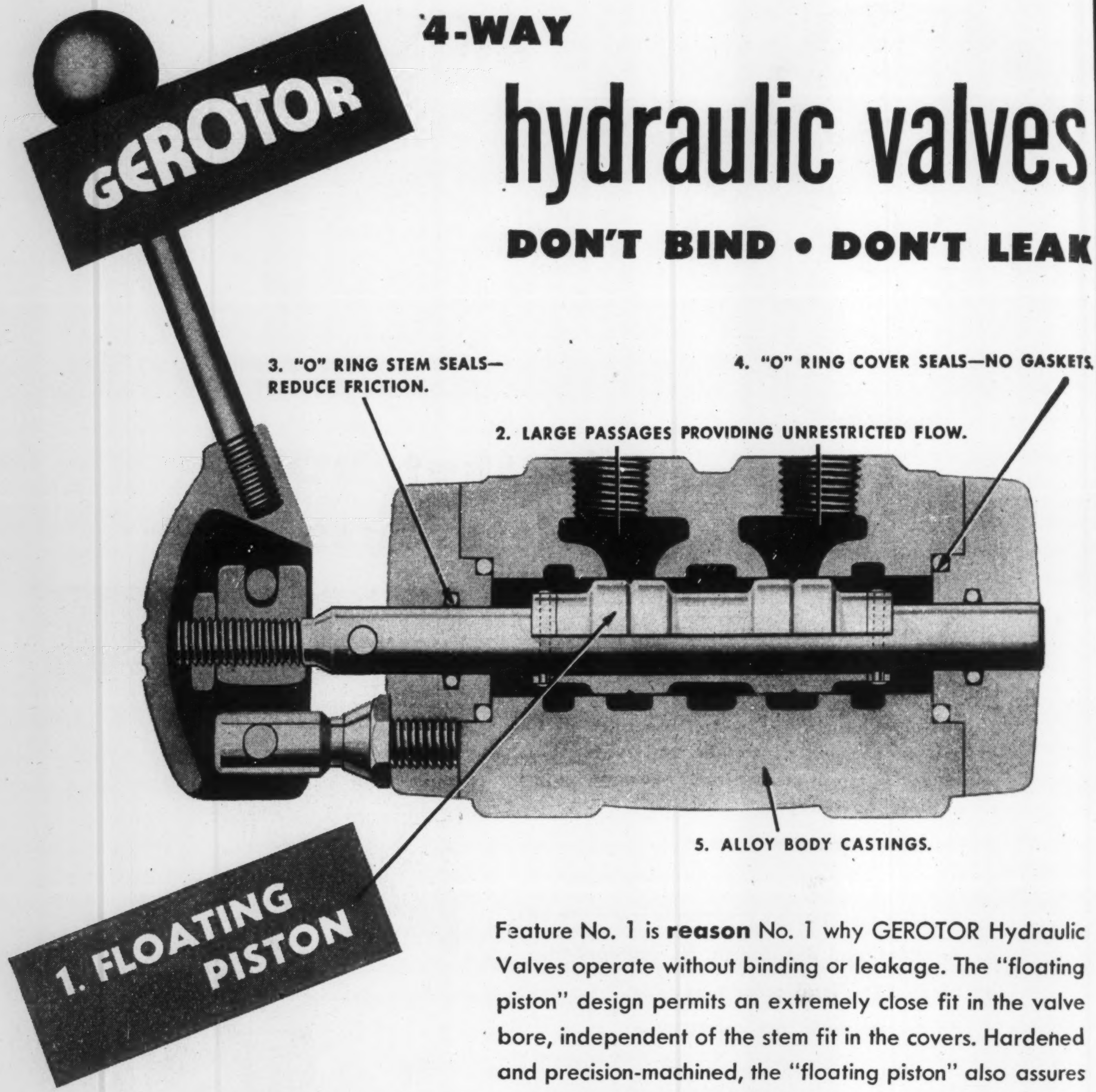
DON'T BIND • DON'T LEAK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3. "O" RING STEM SEALS—REDUCE FRICTION.
4. "O" RING COVER SEALS—NO GASKETS.
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GEROTOR MAY CORP., Baltimore 3, Maryland

GEROTOR

hydraulic pumps, motors, valves and cylinders • air valves and cylinders

NATIONAL OIL SEAL LOGBOOK

CORRECT INSTALLATION IS ESSENTIAL FOR MAXIMUM OIL SEAL EFFICIENCY

Good design, plus careful installation, mean longer, better oil seal performance. Ideally, equipment using oil seals should be designed so that shaft is pushed into assembly from rounded edge of the sealing member. In cases where this is not possible, the following basic installation precautions are doubly important.

Guard the Sealing Lip

A tiny scratch on the sealing lip may cause costly leakage. Sealing lip should be kept from contacting sharp corners, splines, keyways, threads or burrs. This can be done through use of cone-like mounting tool (Fig. 1) or a sleeve fixture (Fig. 2). In using the cone, care should be taken that the cone's O.D. does not exceed shaft diameter by more than 1/32". Otherwise, sealing member will be distorted and efficiency will suffer. Similarly, sleeve fixture O.D. should not exceed shaft diameter by more than 1/32".

Shim stock is not recommended for use as a sleeve. However, if shim stock must be used, lapped edge can be rounded to avoid cutting the sealing member. Or, the lap-joint may be soldered and the butt dressed down to a mirror finish.

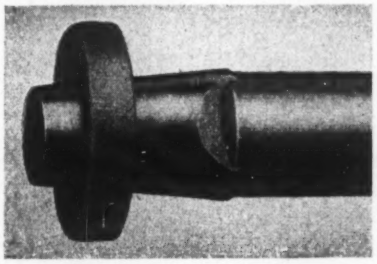

FIG. 1

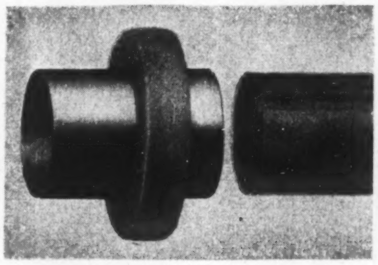

FIG. 2

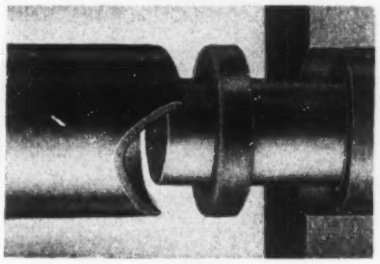

FIG. 3

Avoid Cocking the Seal

Cocking, a frequent cause of oil seal "leakage," can be avoided by using tubular anti-cocking tools (Fig. 3). In cases where press-fit well inside the bore is desired, the anti-cocking tool should be a few thousandths smaller than the seal's diameter. Conversely, if seal is to be press-fit flush with the outside of the housing, diameter of the fixture should be slightly greater. In cases where the seal must be press-fit into an unusually long housing bore, it is advisable to relieve the bore right up to the sealing position. Anti-cocking tools may then be used with ease.

Chamfer Shoulders of Shaft

To further protect the sealing lip, shoulders on shafts should be chamfered. All sharp corners should be rounded. If shoulder is unusually high, a special sleeve tool should be used (Fig. 2). Shafts with polished tapers and no keyways or splines present no problem other than the need of applying pressure evenly to the seal's periphery. But here again, general precautions apply: the smoother the shaft, the more careful and even the installation, the better the oil seal's performance.

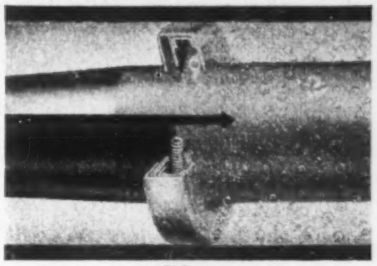

FIG. 4

Pre-lubricate Before Installing

The sealing member must be pre-lubricated regardless of seal type. Wiping the sealing lip with temperature-resistance grease is preferred. But if this is not practical, other greases and other methods can be substituted. Furthermore, for greater seal efficiency and performance, the following precautions should be observed:

1. Sealing lip must point toward fluid to be retained (Fig. 4).
2. The bore should be held to ±.001" and shaft should be held to ±.002". The concentricity of the bore to the shaft should be held to ±.002" indicator reading.
3. Seal must be correct type for the application: leather, rubber, felt, cork, special materials or compounds, etc., any combination of the preceding, springless or spring-loaded.

National Oil Seal Engineers are always ready to assist you with information concerning proper seals for different applications. It may be that one of more than 1000 stock National Oil Seals will help solve your problem. Possibly a special design is indicated. Whatever the case, National Engineers are at your service. Get in touch—today!

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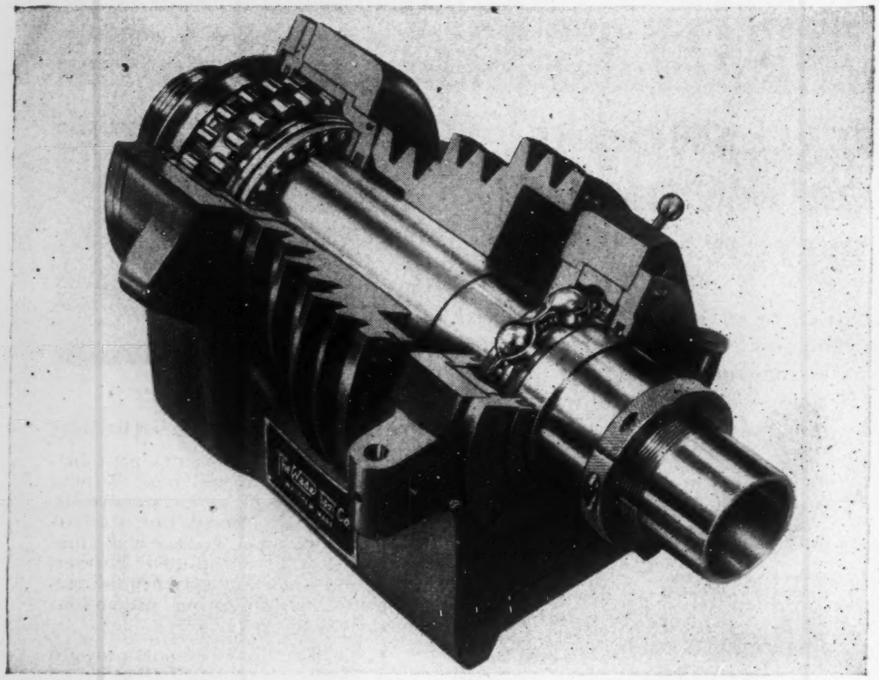

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Here's the SKF Spindle Mounting that assures ***spindle rigidity*** on Wade Precision Screw Machines. An SKF Precision Double-Row Cylindrical Roller Bearing supports the spindle as close to the spindle nose as possible and takes the radial load. An SKF Precision Ball Thrust Bearing, just back of the roller bearing, takes the thrust load. The rear end of the spindle is supported by an SKF Precision Deep-Groove Ball Bearing, which takes the radial load and also opposes the ball thrust bearing. In terms of spindle performance, this bearing mounting provides rapid production of parts to exacting limits and with fine finish, even when produced at high speeds with coarse feeds. For further information concerning the application of SKF Spindle Mountings to turning, boring and grinding machines, send for our new catalog, "Machine Tool Bearings and Spindle Design."

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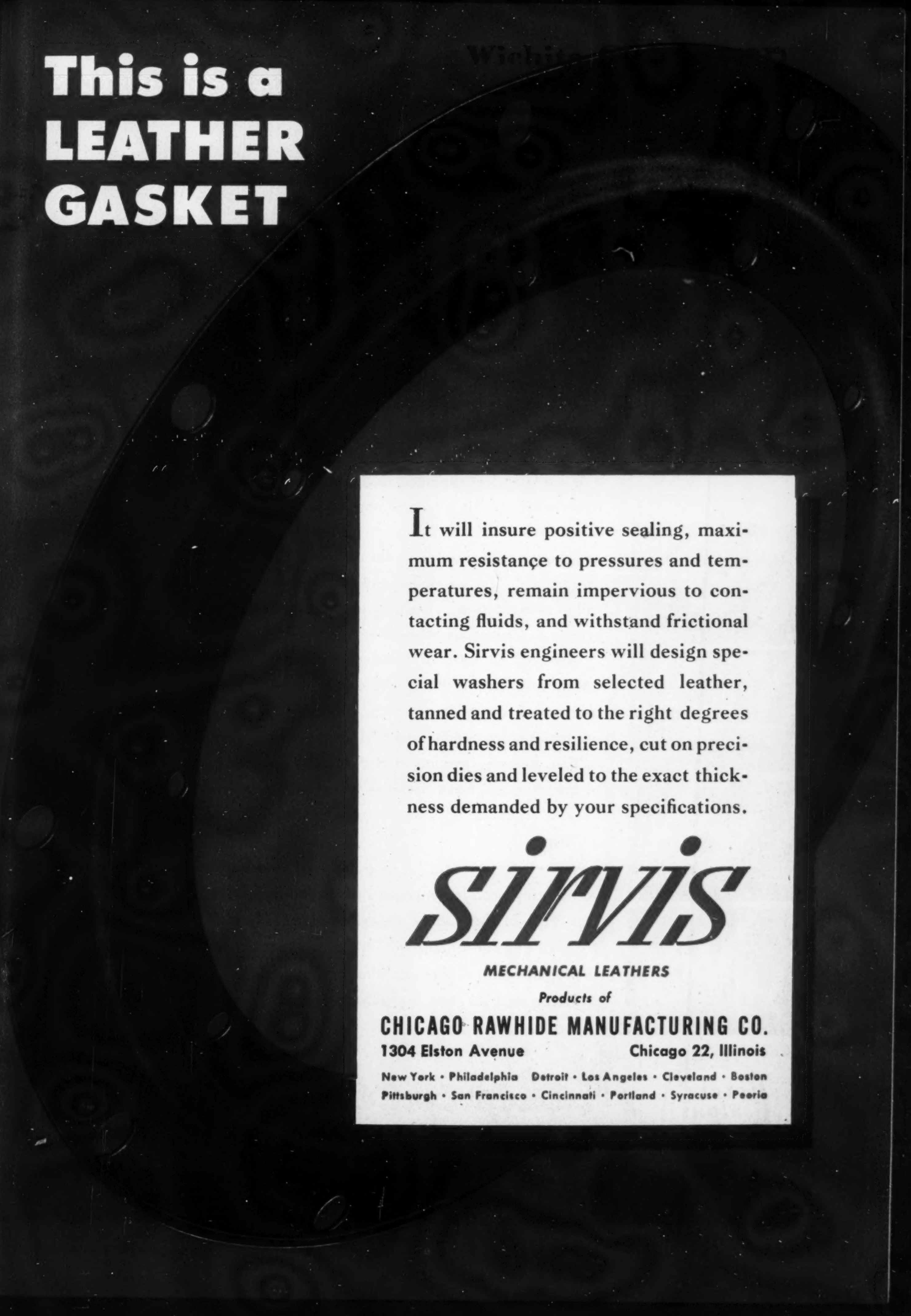

It will insure positive sealing, maximum resistance to pressures and temperatures, remain impervious to contacting fluids, and withstand frictional wear. Sirvis engineers will design special washers from selected leather, tanned and treated to the right degrees of hardness and resilience, cut on precision dies and leveled to the exact thickness demanded by your specifications.

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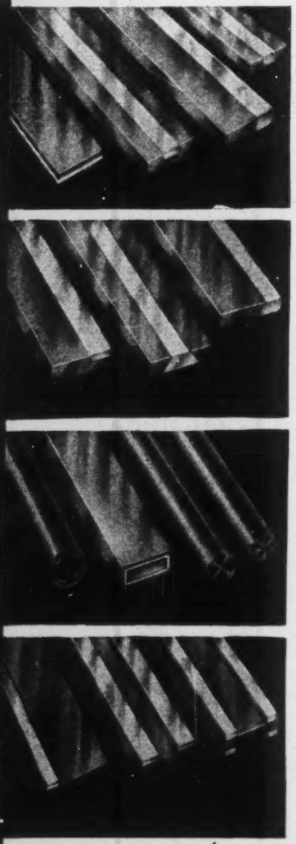

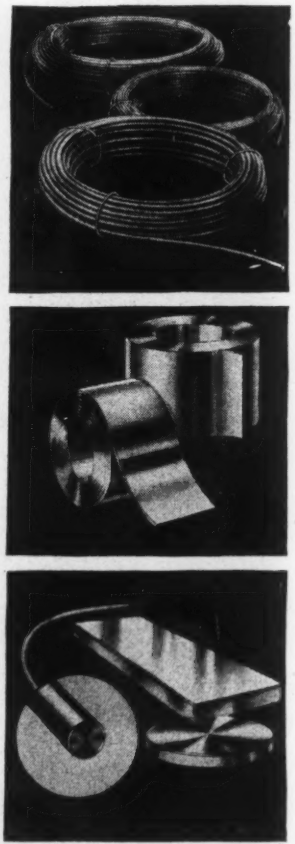

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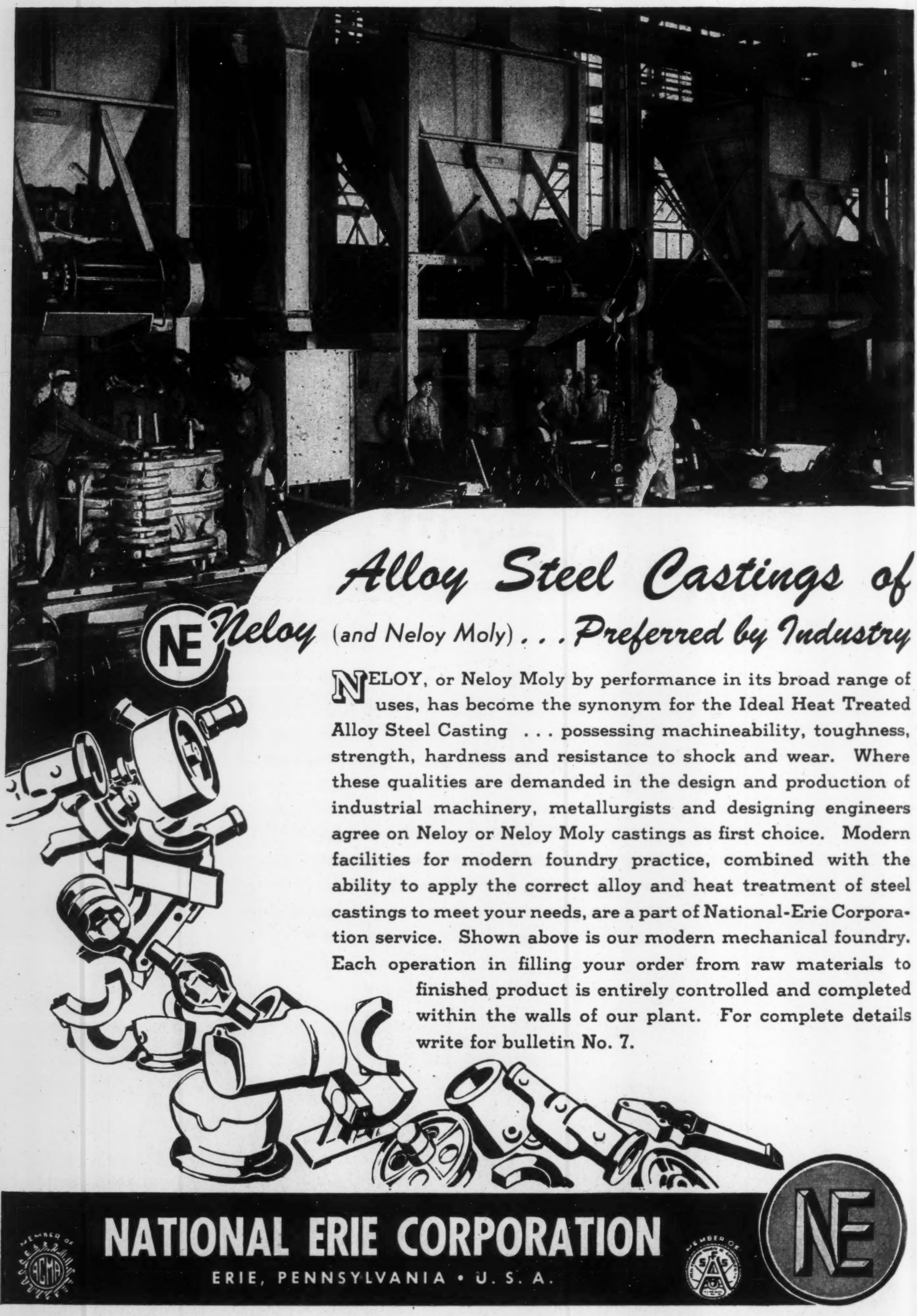
Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Speed Reducers



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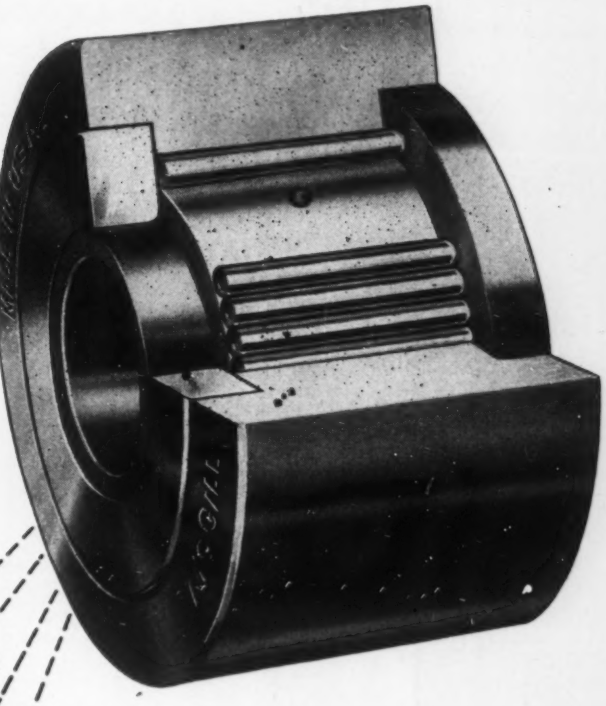

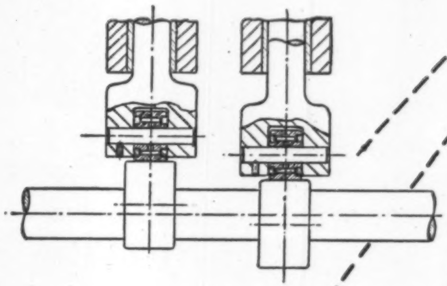

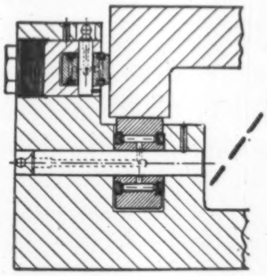

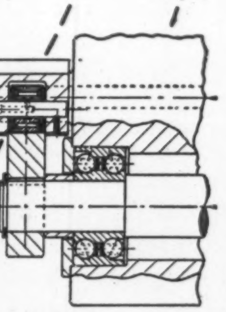

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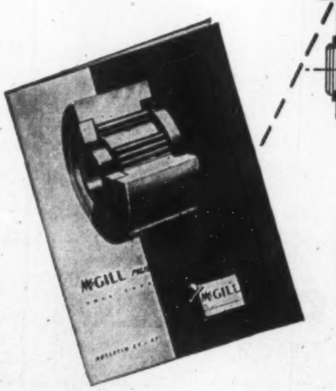

Write for your free copy of Bulletin CY-47 on the new Multirol CYR Bearings.

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precision bearings

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Spongex is used today for hospital pads and bath sponges, chair cushions, furniture upholstery, shoe insoles, typewriter pads, auto window strips, insulation, refrigerator and door gaskets — an infinite number of things — and increasing almost daily.

Made by a company which, for 25 years, has specialized in the production of cellular rubber, *Spongex* is an amazingly versatile material that is solving problem after problem for keen-visioned manufacturers. *Spongex* is available molded to your own specifications or in sheets, tubing, cord, slabs or strips. *Spongex* is carefully controlled as to resiliency, cell structure, tensile strength, and resistance to heat, cold, moisture, oils, acids, corrosive vapors and abrasion.

Whether you're planning improvements in your present products or developing new ones for the future, *Spongex* merits your most serious consideration. Write us describing your individual requirements. Sponge Rubber Products Co., 267 Derby Place, Shelton, Conn. Sales offices in principal industrial centers.

*Reg. U.S. Pat. Off.

SPONGE RUBBER PRODUCTS CO.

SPONGEX* • CELL-TITE* • TEXFOAM* • TEXLITE • TEXLOCK

Man·made
Sandstorm

Dayton Multiple V-Belt Drive transmits power to sand conditioning blade

Drudgery of sand conditioning—the painfully slow method of shoveling—has been replaced by a modern, mechanized method. Now, a lawn mower type, cutting blade cylinder does the work easily, more uniformly. For fast, smooth and dependable power flow the designer specified a Dayton V-Belt Drive. And, as a result, uniform sand conditioning increases foundry production of better castings . . . at less cost per unit.

This is another of the many examples of the flexibility of Dayton V-Belt Drives. The capacity of Dayton V-Belt Drives to perform in excess of standard requirements—under all operating conditions—is another of the many reasons more industrial designers *consistently* specify *Daytons* for original equipment. A Dayton Power Transmission Specialist is ready to help you. Call or write: DAYTON RUBBER · DAYTON, OHIO.

NOW! *Rayon Cords**

PROVIDE DAYTON V-BELTS WITH

1. Minimum Stretch 2. Greater Flex Strength
3. Longer V-Belt Life

* Rayon cords are *specially processed* by Dayton for use in V-Belts to provide the most efficient and economical power transmission service for your machine needs. For the complete story write for booklet A-469.

POWER
Dayton
V-BELT DRIVES

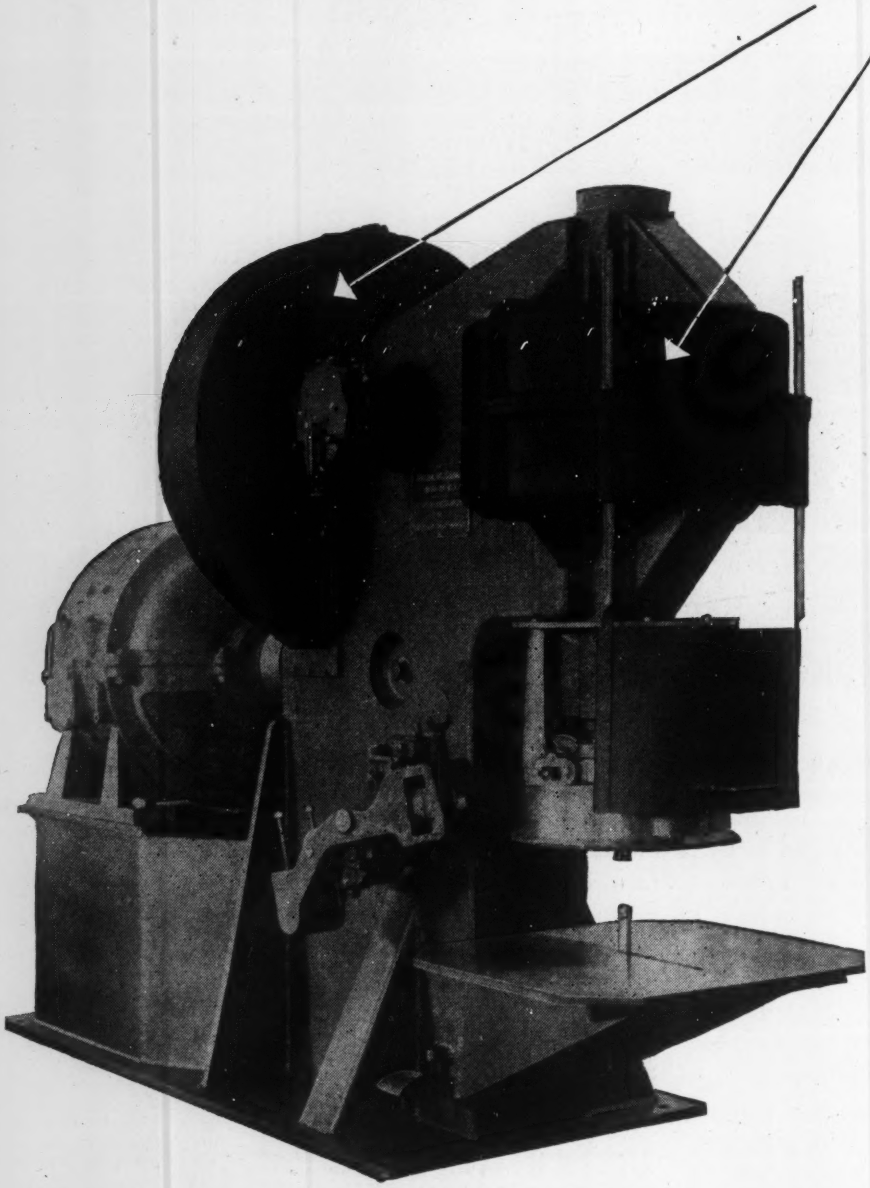
Dayton Rubber

THE MARK OF TECHNICAL EXCELLENCE IN NATURAL AND SYNTHETIC RUBBER

THE WORLD'S LARGEST MANUFACTURER OF V-BELTS

You can build up gear guards or make them the easy way . . .

with LUKENS HEAD-SHAPES



Valuable machine time and labor are required to cut a circle, form a rim, and weld them together. Even then, you're only at the point where the builder of this machine tool started to fabricate his product.

He constructed these gear housings from Lukens Head-Shapes, saving time and money on the job.

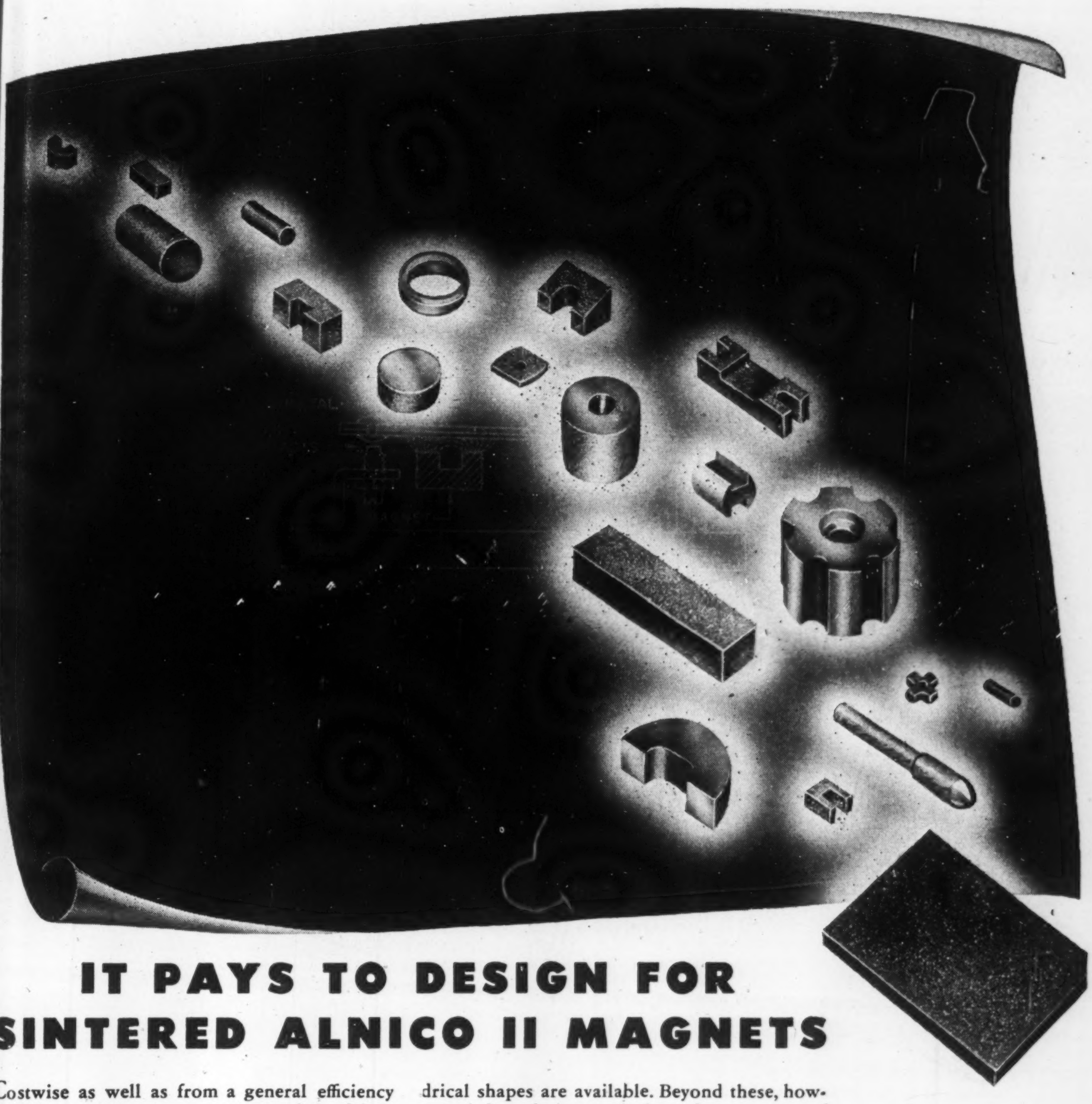
Designers and builders of many products follow this same formula: Select a standard Lukens Head-Shape having the required over-all dimensions; save pattern charges. Proceed from there in fabricating the product. Parts are strong and dependable; they have the predictability and long life of plate products. They are lighter in weight, because thinner sections are safely employed. And best of all, they speed up production while cutting costs.

For help in adapting Lukens Head-Shapes to your production, write Lukens Steel Company, 418 Lukens Building, Coatesville, Pennsylvania.

LUKENS

HEADS ★

FOUR INCHES TO OVER EIGHTEEN FEET IN DIAMETER



IT PAYS TO DESIGN FOR SINTERED ALNICO II MAGNETS

Costwise as well as from a general efficiency standpoint, permanent magnets of Stackpole *Sintered* Alnico II often offer real advantages—especially where odd shapes and small sizes (to approximately 2 oz. weight) are required. Smoother surfaces for easier brazing or soldering, closer tolerances, greater mechanical strength and higher uniformity plus low cost form an unsurpassed combination.

Dies for many standard rectangular and cylindrical shapes are available. Beyond these, however, it is entirely practical to adapt magnets of many unusual shapes to economical sintered production simply by avoiding reentrant angles and having holes, slots and offsets aligned in the direction of molding pressure. Designed in this manner, odd shapes may readily be built into relatively inexpensive dies from which thousands of permanent magnets can be molded without extra machining and forming operations.

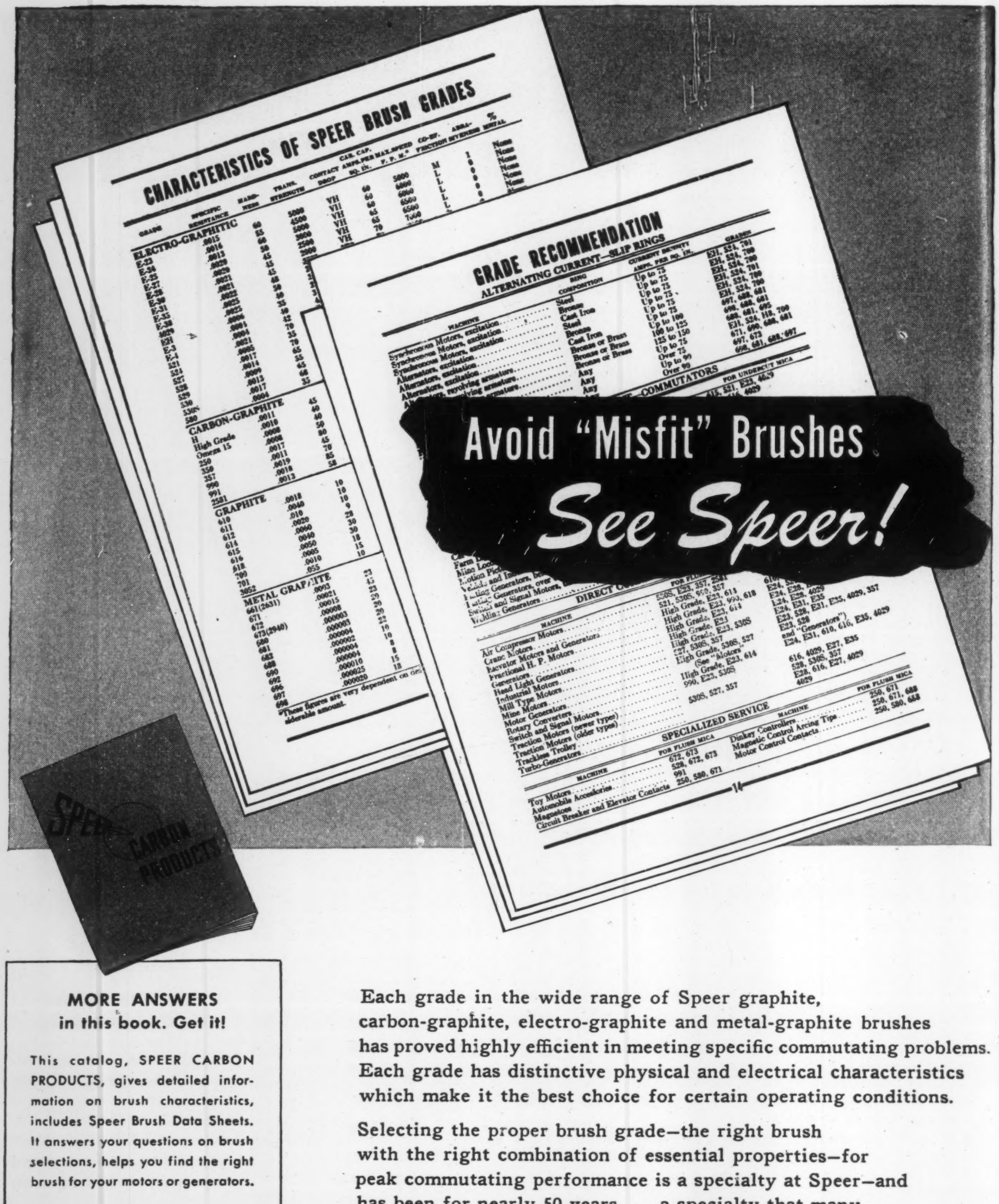
SAMPLES!

Stackpole can produce specific samples of Sintered Alnico II magnets without dies. This service is freely available to prospective users who send full details of required shapes, sizes, and quantities.

STACKPOLE CARBON COMPANY, St. Marys, Pa.

STACKPOLE

BRUSHES and CONTACTS (all carbon, graphite, metal and composition types) • IRON CORES • RARE METAL CONTACTS • ELECTROLYTIC ANODES • WELDING and BRAZING CARBONS • CONTINUOUSLY ADJUSTABLE CARBON RHEOSTAT DISCS • COIL FORMS • MOLDED PUMP AND FLUID DRIVE SEALS • BATTERY CARBONS • BEARING MATERIALS • TROLLEY SHOES, etc.


CHARACTERISTICS OF SPEER BRUSH GRADES
GRADE RECOMMENDATION
ALTERNATING CURRENT—SLIP RINGS
COMMUTATORS
DIRECT CURRENT
SPECIALIZED SERVICE
Avoid "Misfit" Brushes
See Speer!
SPEER
CARBON PRODUCTS

MORE ANSWERS in this book. Get it!

This catalog, SPEER CARBON PRODUCTS, gives detailed information on brush characteristics, includes Speer Brush Data Sheets. It answers your questions on brush selections, helps you find the right brush for your motors or generators.

Each grade in the wide range of Speer graphite, carbon-graphite, electro-graphite and metal-graphite brushes has proved highly efficient in meeting specific commutating problems. Each grade has distinctive physical and electrical characteristics which make it the best choice for certain operating conditions.

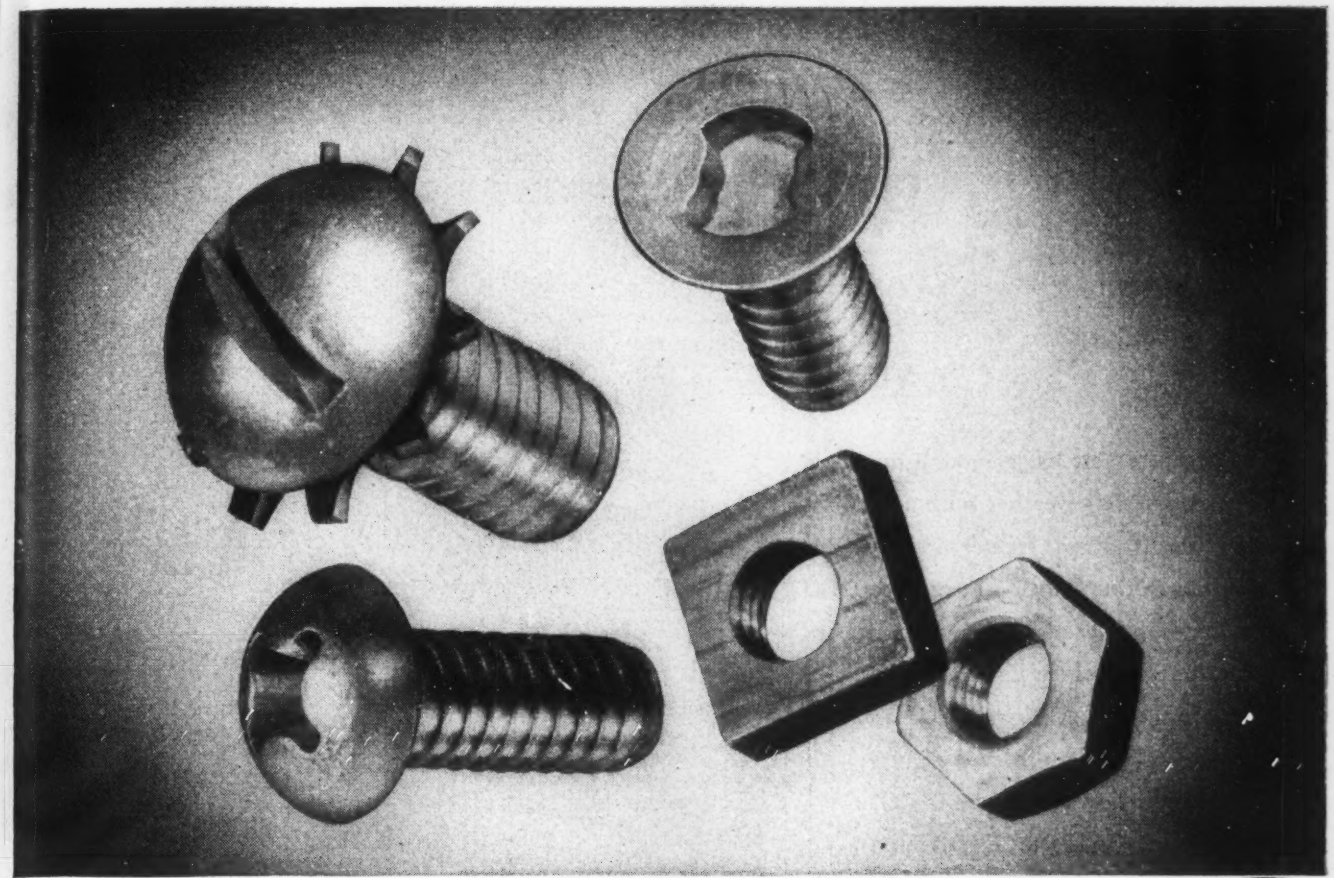
Selecting the proper brush grade—the right brush with the right combination of essential properties—for peak commutating performance is a specialty at Speer—and has been for nearly 50 years . . . a specialty that many designers, builders and users of commutating machines rely on to save time, trouble and expense on brush problems. Perhaps Speer can help you.

2966

Speer
CARBON COMPANY
ST. MARYS, PENNA.

brushes · contacts · welding electrodes · graphite anodes · rheostat discs · packing rings · carbon parts

CHICAGO · CLEVELAND · DETROIT · MILWAUKEE · NEW YORK · PITTSBURGH



WHEN YOU CAN COUNT ON EVERY FASTENER... THAT'S t.f.e. True Fastener Economy!

It's the cost of using a fastener that counts

The saving you can make by being able to depend upon your supplier's "quality control" and by reducing inspection in your own plant, invariably amounts to a greater saving than could be effected if a lower price were available.

R B & W Machine Screws and Stove Bolts
Made to One Quality Standard

At each RB&W plant, quality control is effective at every stage of manufacture—beginning with laboratory analysis of raw materials—*not* just at the end of the production line. The finished product that is delivered to you can be depended upon for uniformly high qualities—giving you a fastening device that assembles at high speed, provides maximum desired holding power and, in terms of finish, is a credit to the appearance of your assembled product.

You Get T. F. E. When You

1. Reduce assembly time to a minimum by savings through use of accurate and uniform fasteners
2. Make your men happier by giving them fasteners that make their work easier
3. Reduce need for thorough plant inspection, due to confidence in supplier's quality control
4. Reduce the number and size of fasteners by proper design
5. Purchase maximum holding power per dollar of initial cost, by specifying correct type and size of fasteners
6. Simplify inventories by standardizing on fewer types and sizes of fasteners
7. Save purchasing time by buying larger quantities from one supplier's complete line
8. Contribute to sales value of final product by using fasteners with a reputation for dependability and finish

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

102 years making strong the things that make America strong

RB&W bolts, nuts, screws, rivets and allied fastening products are manufactured in a broad range of styles, sizes and finishes.

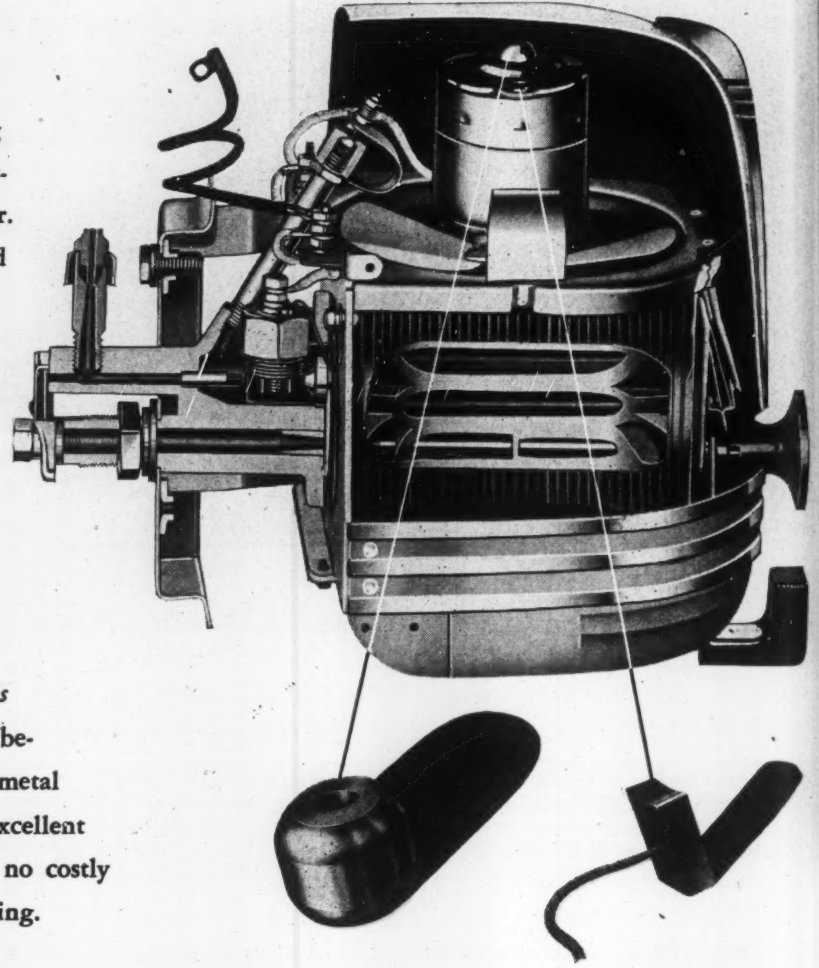
• • •

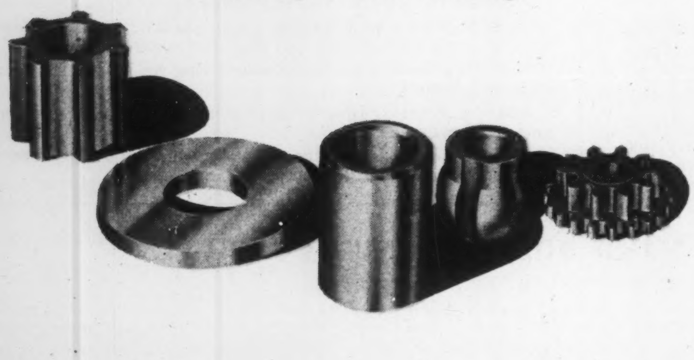
Plants at: Port Chester, N. Y., Coraopolis, Pa., Rock Falls, Ill., Los Angeles, Calif. Additional sales offices at: Philadelphia, Detroit, Chicago, Chattanooga, Portland, Seattle. Distributors from coast to coast. By ordering through your distributor, you can get prompt service from his stocks for your normal needs. Also—the industry's most complete, easiest-to-use catalog.

RB&W
THE COMPLETE
QUALITY LINE

Stewart-Warner South Wind heats your car effectively with help of gramix bearings and U.S.G. brushes

You're warm as toast as you spin along through the coldest weather with a *Stewart-Warner South Wind Heater* in your car. Here's the gasoline burning heater preferred by thousands, because it requires practically no attention whatsoever. Two good reasons for this top dependability are Gramix powder metal bearings and U.S.G. brushes. Installed as shown, the U.S.G. brush provides positive electrical contact . . . it never fails! The Gramix self-aligning bearing keeps the blower operating smoothly and quietly. *It's self-lubricating, it's strong and tough, and it's economical* from a production standpoint because it is die-pressed from powdered metal to close-tolerance size and with excellent bearing surfaces that require no costly machining or hand finishing.





gramix bearings

U. S. G. brushes

In many applications, Gramix parts do the work of conventional machined parts, *better and at lower cost.* Perhaps we can save you money by designing and producing Gramix powder metal bearings, gears, or other parts for your products. If you produce electrical mechanisms, we can supply you with the correct U.S.G. brush—pure graphite, carbon-graphite, or metal-graphite—for your particular application. Just send us sketches of prints of your products for suggestions. **Ask for the big new 264 page Gramix catalog.**

THE UNITED STATES GRAPHITE COMPANY • SAGINAW, MICHIGAN

MATERIAL CUT 66%

. . . BECAUSE
A DESIGNER
"*thought in Circles!*"

Because of its tricky "7"-shaped cross section, this 16-pound supercharger ring used to be machined out of a 50-pound forging. To make a 16-pound part, 34 pounds of special high resistance stainless steel went into scrap.

Then a designer, "thinking in circles", called on Dresser's 65-year experience in making specialized circular parts.

Dresser engineers suggested that a special mill roll section, shaped like a "7", could be produced. This was worked out with a steel mill, and Dresser made the ring by forming the special section into a perfect circle and flash welding the ends together. Now the 16-pound ring requires only 17 pounds of raw material—a saving of 66%. Machining time is similarly reduced.

The same kind of "thinking in circles", the technical ability and specialized equipment that solved this problem, is also available to you. At your invitation, Dresser engineers will gladly sit down to see if they can help you engineer quality into and cost out of your products.

When you send your inquiry, please include a sketch or blueprint and description of use. We'll prepare preliminary estimates and recommendations for you.

HOW
"THINKING IN CIRCLES"
SAVES YOU MONEY...

Dresser starts with stock of the desired cross section... Forms and expands it to accurate size and shape... Flash welds it under rigid control... Leaving you little or no finishing to do.

DRESSER MANUFACTURING DIVISION, 81 FISHER AVE., BRADFORD, PA.

DRESSER RINGS

ONE OF THE DRESSER INDUSTRIES

Acme Almag 55

Now . . . Aluminum Castings with The HIGH TENSILE STRENGTH necessary to Replace Cast and Malleable Iron, Brass, Bronze, and Mild Steel Castings

50,000 to 60,000 p.s.i. tensile strength, yet this is only one of the many important advantages of Acme *ALMAG 55*, a remarkable new aluminum casting alloy.

Now, for the first time, you can get this high strength *plus* elongation 16 to 20% and up . . . *plus* high impact resistance . . . *plus* a beautiful finish . . . *plus* easy machinability . . . *plus* the weight advantages and corrosion-resistance associated with clad aluminum.

Full facts and figures, including information about Acme's modern casting facilities available. Fill out the coupon and mail today.

ANOTHER NEW ACME ALLOY

Acme *ALMAG 35* . . . higher maximum properties in the "as cast" condition than heat-treated aluminum alloys containing silicon, zinc, or copper. Available for sand, die, permanent mold, or plaster. Recommended where a combination of strength, ductility, corrosion-resistance, and machinability are required and where heat-treating is too costly or unavailable. Castings or ingots.

TRIPLE A

Technical Data
Acme
Almag 35
Acme
Almag 55

Send FOR THESE VALUABLE BULLETINS

Please send me the bulletins checked below:

☐ Acme ALMAG 55 ☐ Acme ALMAG 35

Name____________________

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Company____________________

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ACME SERVICES: Aluminum, brass, bronze castings . . . aluminum casting alloys . . . patterns . . . tools . . . engineering . . . rare chemicals and rare metals . . . special specification alloys in ingots or wire.

Acme ALUMINUM ALLOYS, INC.

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Washington . . . Chicago . . . Philadelphia . . . Glendale, Calif. . . . Milwaukee
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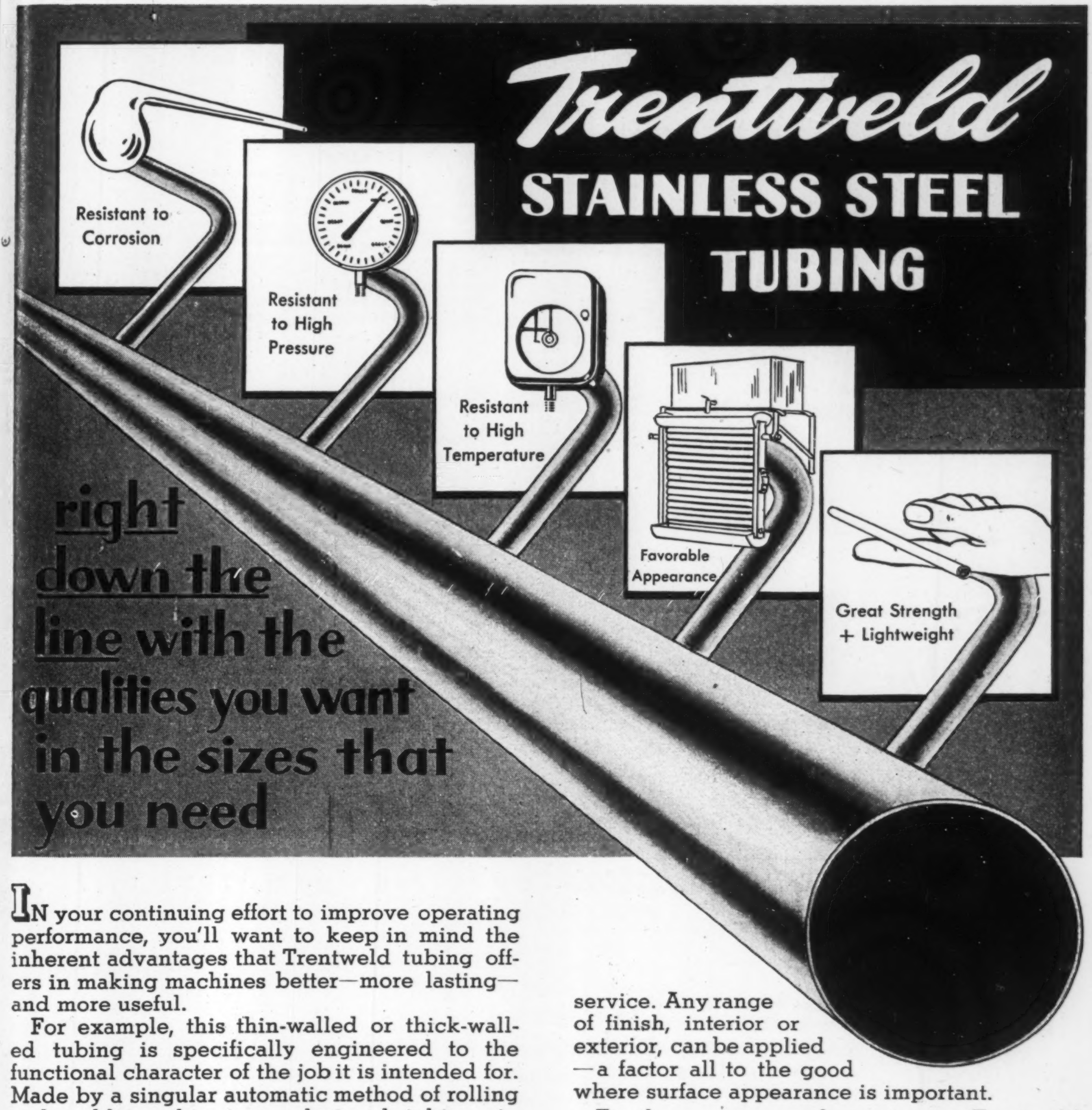
Trentweld
STAINLESS STEEL TUBING


Resistant to Corrosion
Resistant to High Pressure
Resistant to High Temperature
Favorable Appearance
Great Strength + Lightweight
right down the line with the qualities you want in the sizes that you need

IN your continuing effort to improve operating performance, you'll want to keep in mind the inherent advantages that Trentweld tubing offers in making machines better—more lasting—and more useful.

For example, this thin-walled or thick-walled tubing is specifically engineered to the functional character of the job it is intended for. Made by a singular automatic method of rolling and welding, this new, advanced tubing, in thin-walled or thick-walled form, is unusually uniform in composition and structure. Pickling and annealing operations are precisely controlled and adjusted to the end application of the tubing. The net result is a fine-grained metal—stainless steel or Inconel—so homogeneous, so completely free from inclusions, so especially treated for severe industrial requirements, that it has far more than an ordinary capacity for service. Any range of finish, interior or exterior, can be applied—a factor all to the good where surface appearance is important.

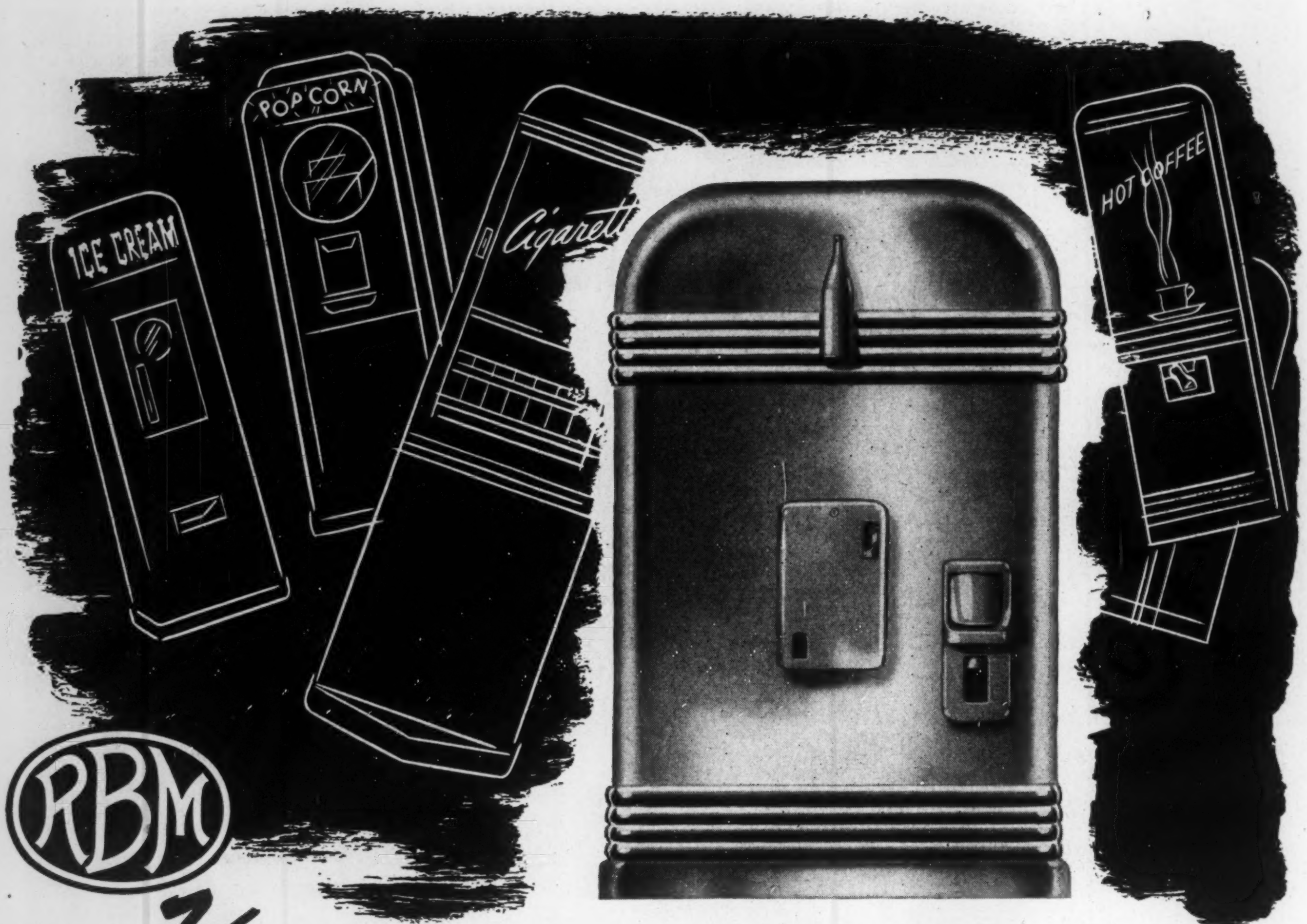
For these reasons and many more, Trentweld tube, in diameters from 1/8" to 24", is being used today by many top-ranking American manufacturers. Feel free to call on Trentweld engineers—as others have—to put a shoulder to the wheel on any application you have in mind. Draw on their wide experience without obligation. Address—Department 21 or write for the Trentweld Data Bulletin.

Sales Office—664 N. Michigan Avenue, Chicago 11, Illinois

TRENT TUBE MFG. CO.

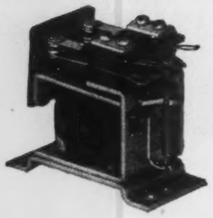
TRENTWELD STAINLESS STEEL TUBES

Mill at East Troy, Wisconsin


ICE CREAM
POP CORN
Cigarett
HOT COFFEE
RBM

VENDING MACHINE CONTROLS

ENGINEERED TO *YOUR* SPECIFIC REQUIREMENTS



RELAYS
Magnetic relays including vending and anti-jackpot relays.

SOLENOIDS
A. C. Work Solenoids available in standard or special designs and sizes.

HARNESSES
Complete wiring harnesses with all electrical controls to meet the requirements of any type vending machine.

R-B-M offers you a *single source* for complete engineering service and manufacturing facilities to provide proper electrical relays, solenoids and control accessories *completely wired* to your specifications.

You save time, trouble and money with this complete service! Our staff of experienced engineers will work with you in analyzing your electrical problems—either on present or contemplated machines—and assist in devising the most efficient and economical control system.

Our production facilities provide quick delivery of a few control assemblies for development and field trial models—or a steady production run regardless of quantity.

Let R-B-M lay out your vending machine control assemblies—there is no obligation. Address Department H-12.

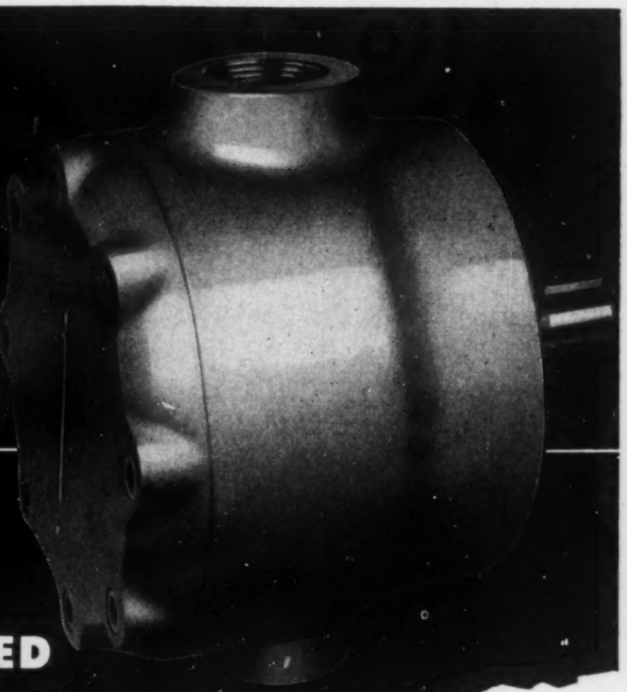
R-B-M DIVISION • ESSEX WIRE CORPORATION
Logansport, Indiana

RBM
MANUAL AND MAGNETIC ELECTRIC CONTROLS — FOR AUTOMOTIVE, INDUSTRIAL, COMMUNICATION AND ELECTRONIC USE

CHECK THE

7 Features

OF THIS CONSTANT VOLUME HYDRAULICALLY BALANCED SUNDSTRAND PUMP



7 Features that mean Better Pump Performance

1. Pumping action distributed to maintain complete pressure balance — reduces bearing loading to a minimum.

2. Multi-porting connects all pumping areas — assures unrestricted flow.

3. New design provides a pump with large displacement within a realtively small housing.

4. Cartridge sub-assembly simplifies pump inspection and service — provides means for quick change of pump rotation and pump capacity within range.

5. Drive shaft is a floating member supported at each end by anti-friction bearings.

6. New mechanical oil seal design prevents oil leakage along shaft.

7. Correct materials and material treatment plus foregoing features substantiated by endurance tests and field applications.

Yes, here's a pump designed to perform efficiently on your equipment and machines. It'll perform better because of hydraulic balance—there is torque load on the shaft only, no hydraulic load. A maximum of fluid energy is delivered rather than dissipated in operation of the pump. Study the outstanding features of this new pump. Our hydraulic application engineers will be glad to assist you in its proper application.

SOME TYPICAL APPLICATIONS

USES — A design of this nature lends itself to potential application for machine tools, lift trucks, dump trucks, industrial tractors, farm tractors, loaders, stackers and similar equipment or where-ever it is desirable to obtain maximum performances within limited or small areas.

FREE DATA: Write for new bulletin and specifica-sheet today. Ask for bulletin No. M-23.

Constant Displacement
Hydraulically Balanced
PUMP
7 OUTSTANDING FEATURES...
SUNDSTRAND
HYDRAULIC DIVISION

SUNDSTRAND HYDRAULIC DIVISION

SUNDSTRAND MACHINE TOOL CO. ROCKFORD, ILLINOIS, U.S.A.

2559 ELEVENTH STREET • ROCKFORD, ILLINOIS

FUEL UNITS • HYDRAULIC PUMPS • TRANSMISSIONS • FLUID MOTORS • VALVES and CONTROLS

BECAUSE IT'S *Tough* TO HANDLE STEEL—

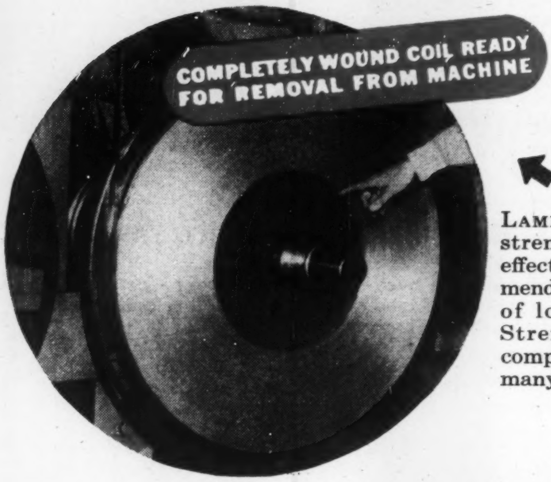
. . . Acme Steel Company of Chicago, Illinois, uses reels made of LAMICOID laminated plastic for winding circular steel coils.

LAMICOID CORE BEFORE APPLICATION TO REELS

Easy to machine, Lamicoid is readily adapted to mass production methods . . . can be worked to metal-precision tolerances . . . will retain its accurate dimensions and shape despite severe usage.

CORE ON REELER READY TO COIL

Light weight of Lamicoid enables reel to be started and stopped quickly—with minimum effort. It's high impact strength resists sudden variations in coil tension.



Lamicoid's exceptional strength and toughness effectively withstand tremendous load of hundreds of loops of steel coil. Strength-weight ratio compares favorably with many metals.

A grade of Lamicoid can be chosen to meet specific product requirements. The wide range of fabric or paper bases—laminated with the proper thermosetting resins—offers designers and manufacturers a selection of materials possessing high electrical and mechanical strength and excellent working qualities. For example, some types resist most oils and solvents as well as many acids and salts. All grades of Lamicoid have low moisture absorption values.

Let our technical representative interpret Lamicoid's many advantages in terms of your particular needs.

COIL IS TIED AND REMOVED FROM LAMICOID CORE

Outstanding wear and abrasion resistance enable Lamicoid core to be used over and over . . . with consequent savings in replacement costs.

Photos by Acme Steel Company, Chicago

MICA INSULATOR COMPANY

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Atlanta • Birmingham • Boston • Chicago • Cincinnati
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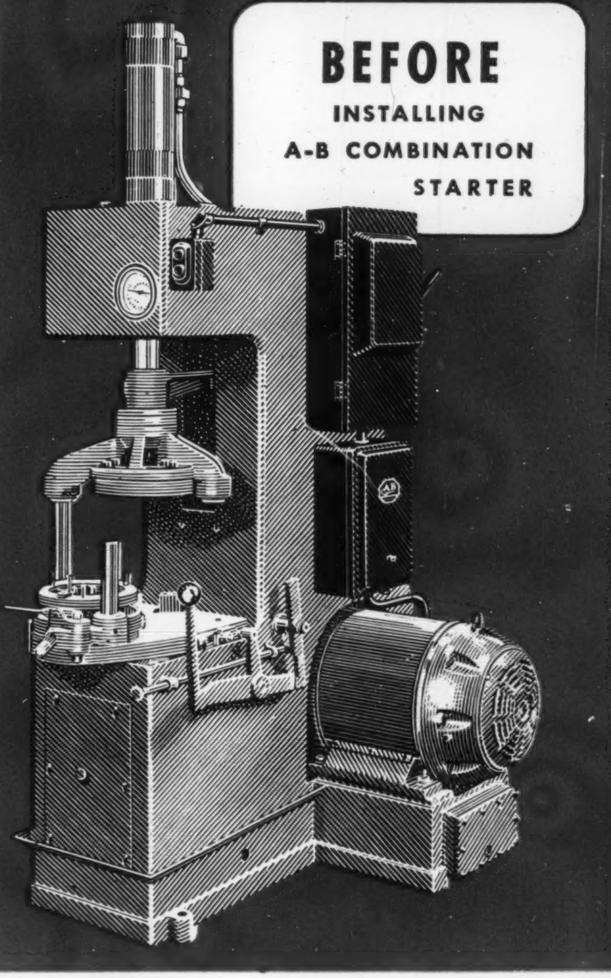
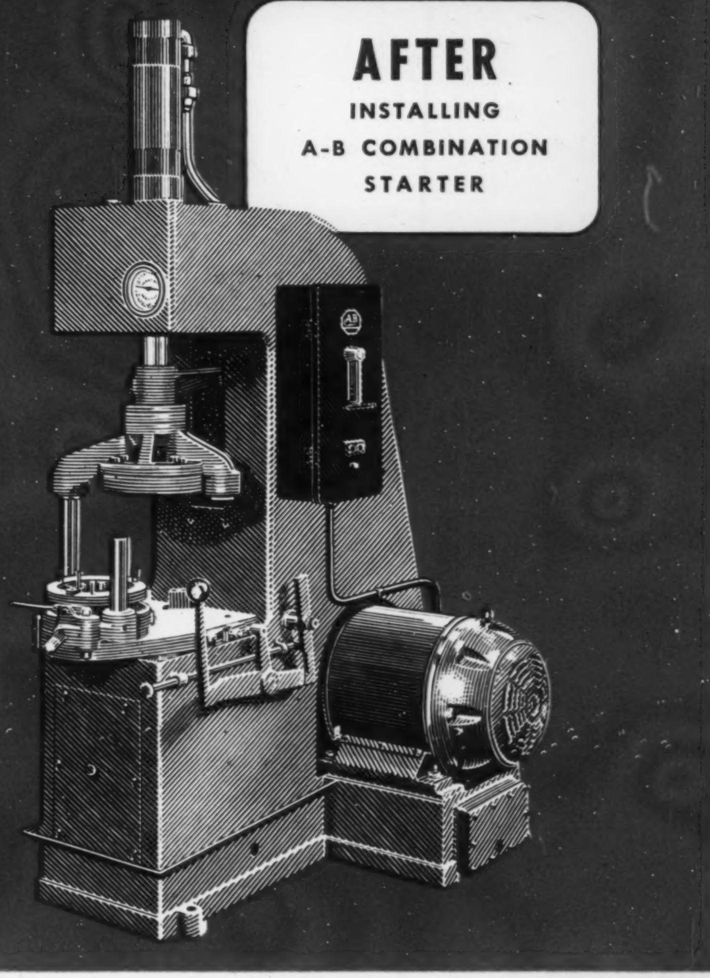
Philadelphia • Rochester • St. Louis • San Francisco

FABRICATORS: Lamicoid Fabricators, Inc., Chicago, Ill. • Bakoring, Inc., Houston, Texas • Insulating Fabricators, Inc., New York City
Insulating Fabricators of New England, Inc., Watertown, Mass.

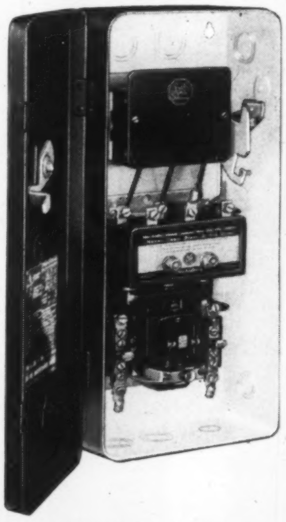




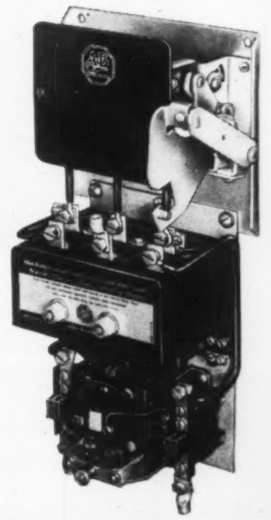
THREE UNITS REPLACED BY ONE COMBINATION STARTER

Saves Space—Reduces Cost—Makes Neater and Safer Installation

BULLETIN 712 COMBINATION STARTER



Cover cannot be opened unless disconnect lever is "OFF."



Disconnect unit and switch are mounted on one back plate.

● Compactness . . . that is a requirement of modern machine tool design.

For example: The old way (see above) called for three separate units . . . (1) disconnect switch . . . (2) motor starter . . . and (3) push button station.

The new way (see above) calls for ONE unit . . . an Allen-Bradley Combination Starter, with push button, magnetic switch, and disconnect unit in ONE neat cabinet.

This compact construction saves space . . . reduces cost . . . makes a neater and safer installation. For full information send for Bulletin 712-713 describing A-B Combination Starters in various types of enclosures.

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.

ALLEN-BRADLEY

COMBINATION STARTER

The Starter that introduced a New Era *in Automatic Motor Controls*

When Allen-Bradley engineers combined the straight-line motion of a solenoid plunger with the high arc-disruptive action of confined, silver alloy contacts, a new era in automatic motor controls was born.

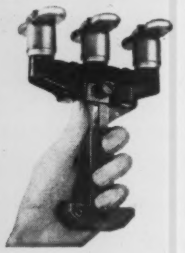
The Solenoid Principle

The solenoid principle permitted a switch design of unmatched simplicity . . . a starter so devoid of trouble-breeding parts, like pins, pivots, bearings, etc., that the Allen-Bradley solenoid starter was recognized everywhere as "trouble-free."

The Contactor Design

The contactor design, utilizing double break contacts of Allen-Bradley patented silver alloy, did away with the old, complex arrangements of lever arms, hinges, flexible jumpers, and rolling-type contacts.

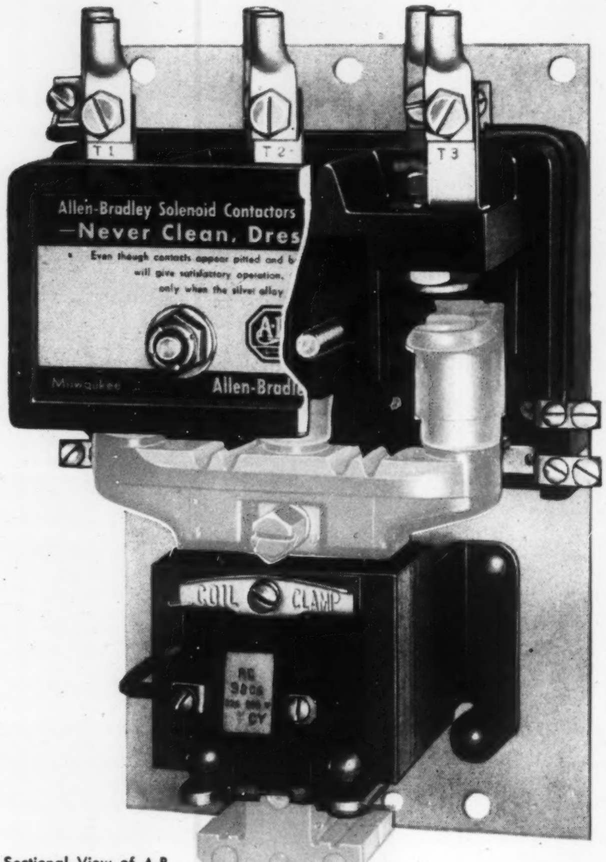
For the first time in all control history, the feature of NO CONTACT MAINTENANCE was made available to control users.



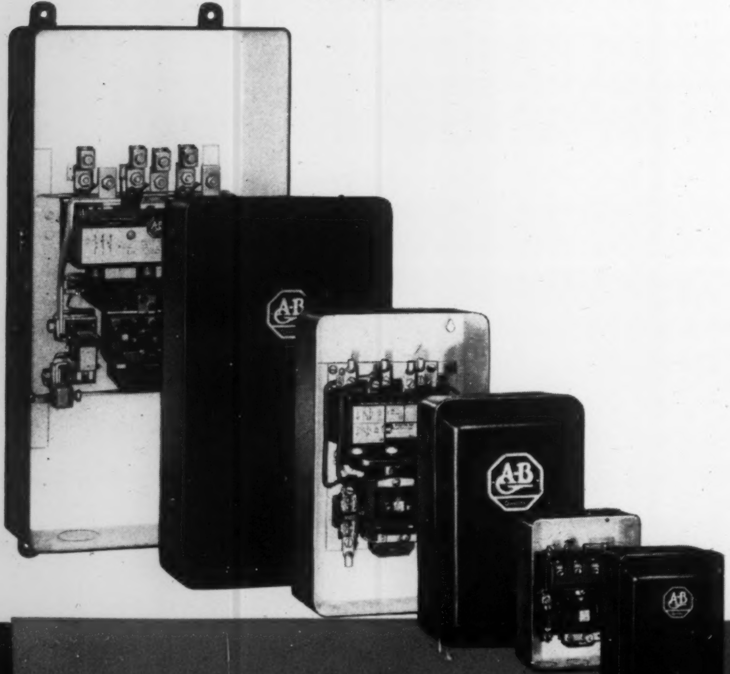
Double break, moving contacts mounted on insulating crossbar.

Today, every Allen-Bradley solenoid starter carries the instruction—"NEVER CLEAN, FILE, OR DRESS THE CONTACTS." Why? Because the silver oxides which may form on the contact surfaces are good conductors. To file the contacts would only waste valuable contact life.

You can install Allen-Bradley Bulletin 709 Solenoid Starters . . . and forget them.


T1
T2
T3
Allen-Bradley Solenoid Contactors
—Never Clean, Dres
Even though contacts appear pitted and b
will give satisfactory operation,
only when the silver alloy
Milwaukee
Allen-Bradle
COIL
CLAMP

Sectional View of A-B Solenoid Switch without Overload Relays.



The Allen-Bradley line of solenoid starters includes six sizes, ranging up to 200 hp. White cabinet interiors make wiring easy. Enclosures are available for every service.

Only ONE Moving Part

DEPENDABLE, TROUBLE-FREE PERFORMANCE

. . . Precision High-Speed Switching for Automatic Sequence Controls

Freedom from complicated linkages, pivots, and hinges makes the simple Allen-Bradley solenoid switch ideal for controlling machine tools. Allen-Bradley switches open and close with split-second accuracy . . . not once or twice . . . but continuously. Such precision is now accepted as "standard" by many machinery builders who depend upon Allen-Bradley controls for high-speed, sequence operation of their machine tools.

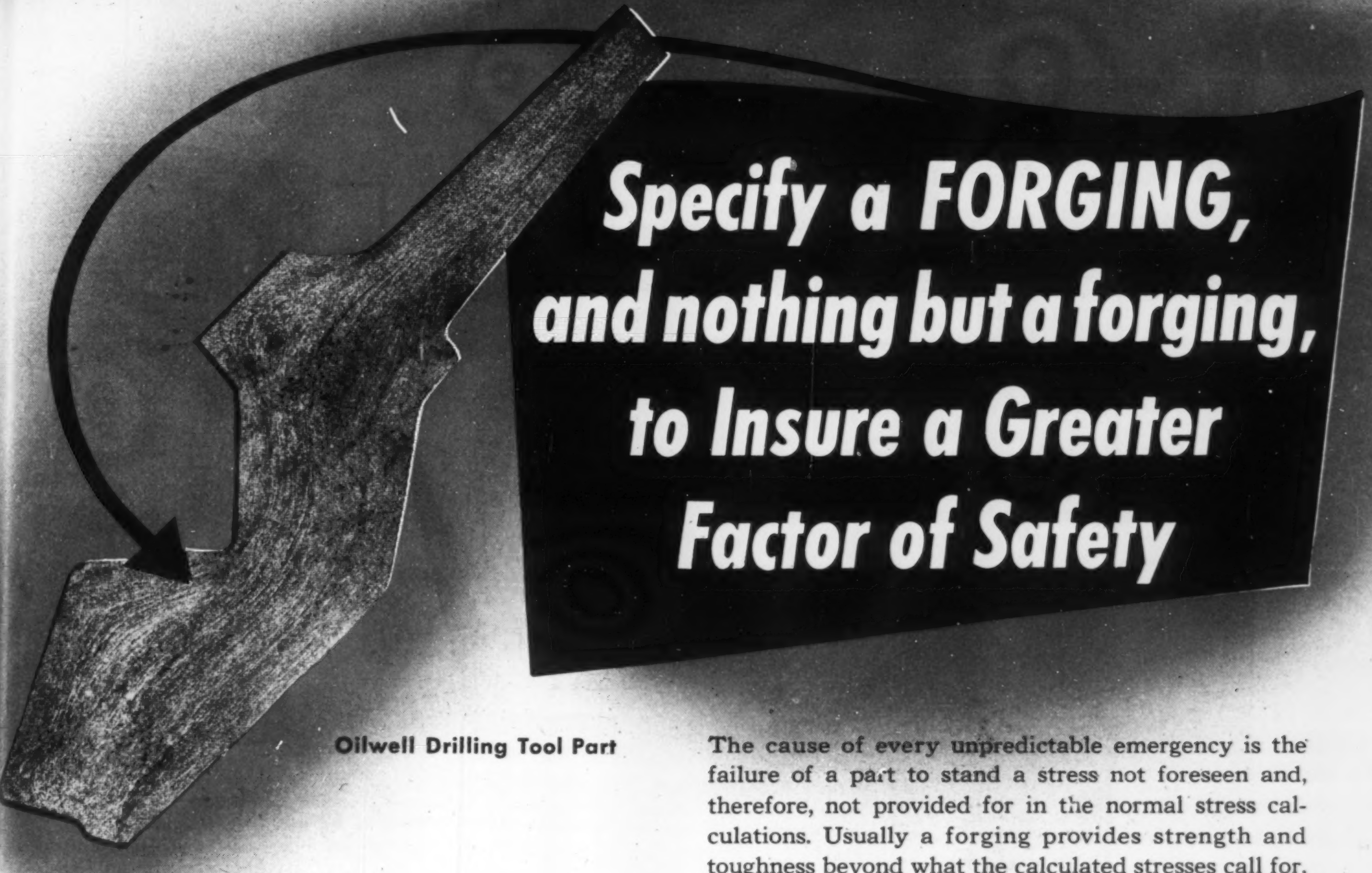
Let us send you Bulletin 709.

Allen-Bradley Co., 1316 So. Second St., Milwaukee 4, Wis.

ALLEN-BRADLEY

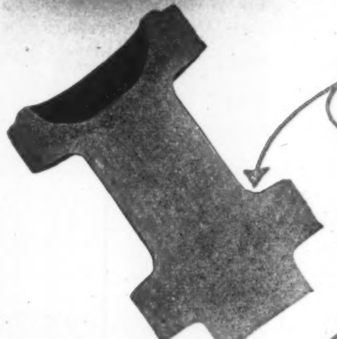
QUALITY

SOLENOID MOTOR CONTROL



Specify a FORGING, and nothing but a forging, to Insure a Greater Factor of Safety

Oilwell Drilling Tool Part

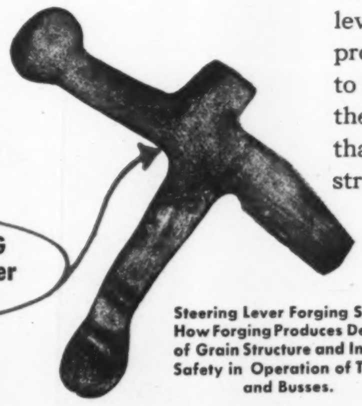


Specify a FORGING
to Insure a Greater
Factor of Safety

Note Concentration of Grain Structure in Gear Tooth Portions of this Cluster Gear Forging.

Specify a FORGING
to Insure a Greater
Factor of Safety

This shows Result of Forging Pinion Rack in Closed Impression Dies. Note how Flow Lines Reinforce Teeth.



Specify a FORGING
to Insure a Greater
Factor of Safety

Steering Lever Forging Shows How Forging Produces Density of Grain Structure and Insures Safety in Operation of Trucks and Busses.

The cause of every unpredictable emergency is the failure of a part to stand a stress not foreseen and, therefore, not provided for in the normal stress calculations. Usually a forging provides strength and toughness beyond what the calculated stresses call for, and is one reason why forgings are often relied on to forestall unpredictable emergencies. The forging method of fabricating parts in closed impression dies directions, controls, and concentrates the fiber-like flow line structure of metals at points of greatest shock and stress.

Forgings reduce parts failures and protect you and your customer from unpredictable emergencies. Forgings provide rapid assembly of complex parts by welding adaptability of widest range; forgings permit reduction of dead weight because maximum strength and toughness is obtainable in lighter sectional thicknesses. There is no substitute for the metal quality and cost reducing advantages of forgings. A recheck of every stressed part, as well as simple handles and levers, frequently reveals opportunities to improve a product, to reduce the cost of machining and finishing, to speed up assembly. Consult a forging engineer while the part is in the design stage because it is important that the design utilize fully the fiber-like flow line structure obtainable in forgings.

METAL QUALITY
HOT WORKING IMPROVES PROPERTIES OF METAL
TOPICS

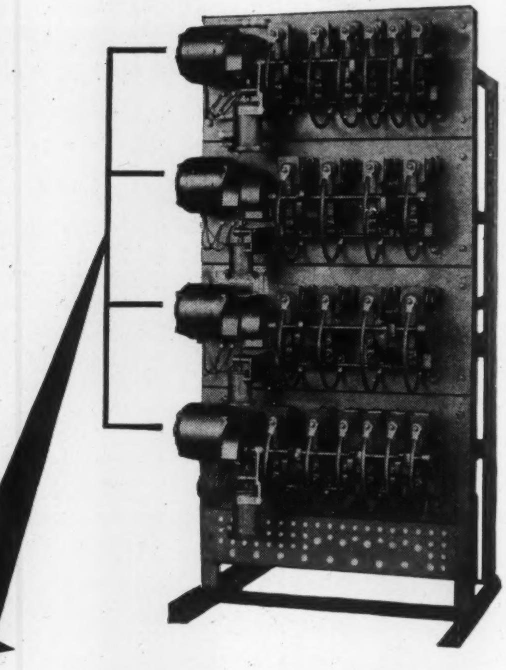
DROP FORGING ASSOCIATION
605 Hanna Building • Cleveland 15, O.

☐ Booklet on "Metal Quality – Hot Working Improves Properties of Metal."
☐ "Drop Forging Topics."

Name .... Position ....
Company ....
Address .... City........ State........

DROP FORGING ASSOCIATION

605 HANNA BUILDING • CLEVELAND 15, OHIO



FOUR 15 OZ. FEET Ohio Motors are used to operate this four-panel Haughton controller. Ohio torque motor ratings range from one to 96 oz. feet—for 10% to 100% locked service. Write for details on these and other Ohio Motors today.

Motors start stalling when she starts up

There's a lot of activity upstairs when elevators start up—or down. But passengers in Haughton elevators don't *hear* what happens because torque motors, like electrical hands, close contactors deftly . . . *quietly*.

Ohio torque motors rotate contactor arms to close directional and acceleration circuits. These compact motors then stall across the line, exerting constant torque on contactors to keep them closed until the operator stops the car.

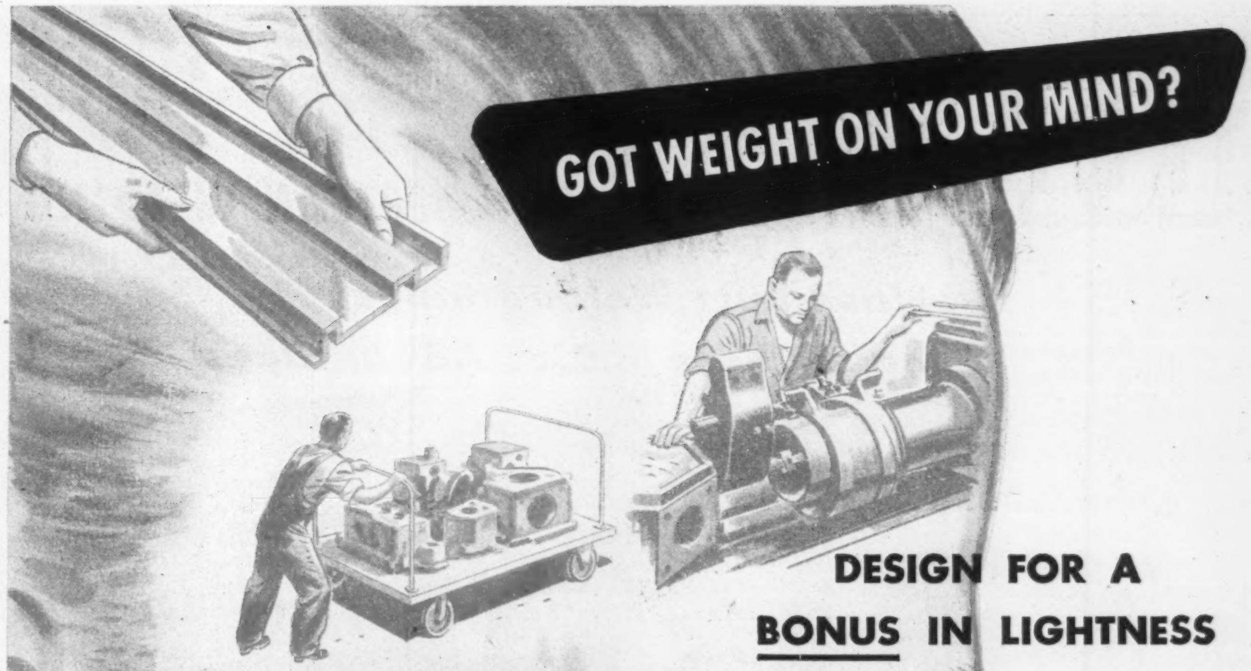
A leading A-C elevator builder today, Haughton Elevator Company engineered the first improved A-C elevator in 1920. In that year Ohio Electric worked with Haughton engineers to develop a suitable torque motor for controller panels, door operators, brake magnets, door retiring cams.

Today in many Haughton elevator shafts you will find as many as *twelve Ohio torque motors*.

For more than 25 years leading manufacturers have simplified difficult design problems with Ohio torque motors. Make Ohio Electric *your* supplier of torque motors too.

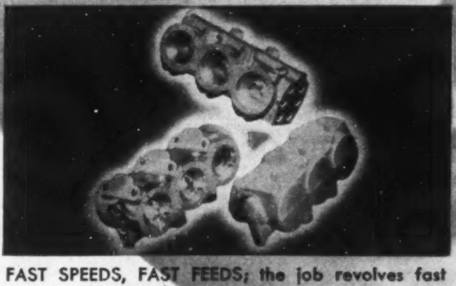
ohio
MOTORS

THE OHIO ELECTRIC MFG. CO. 5906 MAURICE AVENUE • CLEVELAND 4, OHIO


GOT WEIGHT ON YOUR MIND?

DESIGN FOR A BONUS IN LIGHTNESS

MACHINING COSTS come down when you use American Magnesium. Magnesium can be cut as fast as your machines can work—and faster.



FAST SPEEDS, FAST FEEDS; the job revolves fast and the tool moves fast with magnesium. You can deep cut.

FINE FINISH means less time needed. With magnesium you get the end result in less time, with fewer operations.

If you feel you don't know enough about magnesium to take full advantage of its light weight in your designs, get in touch with American Magnesium. For 59 years, the engineers have been passing on know-how in light metals.

If you can do a job and have it 35% lighter than aluminum and 75% lighter than steel, why lose money dragging useless weight?

Magnesium can be welded, stamped, cast, forged, extruded. Wherever it is used, it pays its way. More and more American Magnesium is being engineered into more and more types of products. Many intricate, semi-fabricated shapes can be easily incorporated into designs. You've nothing to lose by investigating. Write or call your nearest Alcoa Sales Office. ALUMINUM COMPANY OF AMERICA, Sales agent for American Magnesium Products, 1703 Gulf Building, Pittsburgh 19, Pennsylvania.

MAGNESIUM MAZLO Reg. U.S. Pat. Off. PRODUCTS

AMERICAN MAGNESIUM CORPORATION

SUBSIDIARY OF ALUMINUM COMPANY OF AMERICA

RINGS by AMERICAN WELDING

Flash Butt Welded Rings have these Major Advantages

1. **Rolled Product**
   Accuracy of dimension tolerances obtained in flat rolled bars or plate is reflected in finished rings.
2. **Uniformity of Structure**
   Made from flat rolled steel, American welded rings are free from blow holes and harmful inclusions.
3. **Variety of Analyses**
   More readily obtainable in bars and plates is a wide variety of analyses which assures the opportunity of specifying the material for the job.
4. **Savings of Materials**
   In comparison with other methods, amount of material to be removed in machining or finishing is held to a minimum.

The flash butt weld used in the fabrication of our rings is a forged weld, made without any metal being added. For purposes of design, it has the same physical properties as the parent metal.

Welded rings are now being used for electrical motor frames, gear blanks, bearing races, clutches, flanges and boiler elements, in stainless and other heat and wear resistant materials, to mention just a few. They have stood the test by any method of comparison.

As pioneers in welded ring production, we will be glad to show you how they can be applied to your products—help you to produce better, quicker and more economically. Write for illustrated booklet.

THE AMERICAN WELDING
AND MANUFACTURING COMPANY
3000 GRISWOLD ST. • WARREN, OHIO

BURKE'S *New Induction Motor*

RESULT OF 41 YEARS INDUCTION MOTOR EXPERIENCE

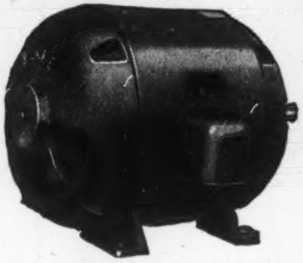
Rotor LAMINATIONS OF HIGH GRADE ELECTRICAL SHEET STEEL, SECURELY KEYED TO SHAFT SPIDER. ROTOR BARS OF HARD DRAWN COPPER STRIP FIRMLY EMBEDDED IN PARTIALLY CLOSED ROTOR SLOTS. EXTENSION OF ROTOR BARS PROVIDES AMPLE FAN ACTION FOR EFFICIENT VENTILATION.

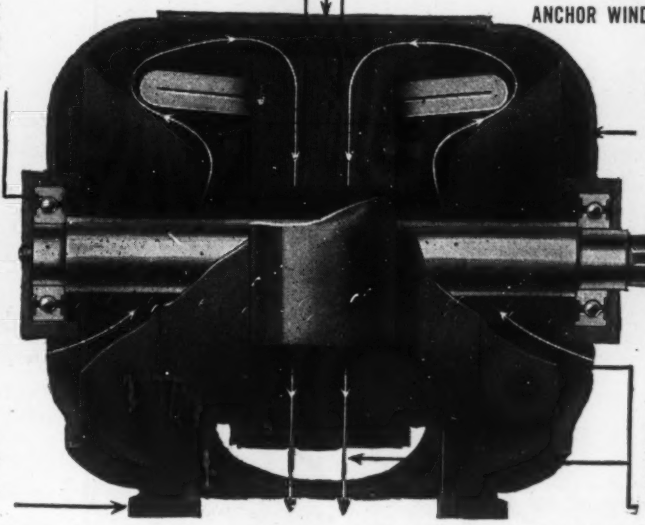
Frame OF ROLLED, WELDED STEEL FOR GREATEST RIGIDITY WITH MINIMUM BULK AND WEIGHT.

Stator CORE, OF HIGH GRADE ELECTRICAL SHEET STEEL, IS INDEPENDENT OF SUPPORTING FRAME; AND RIGIDLY WELDED INTO PLACE TO MAINTAIN PERFECT ALIGNMENT. STATOR COILS ARE WOUND WITH NEW SYNTHETIC RESIN-COVERED WIRE PROVIDING EXCELLENT DIELECTRIC STRENGTH AND MAXIMUM EFFICIENCY. FIBRE WEDGES SECURELY ANCHOR WINDING IN THOROUGHLY INSULATED SLOTS.

Ball Bearings ARE OF DOUBLE SEAL, PRE-LUBRICATED TYPE. NO FURTHER LUBRICATION NECESSARY DURING NORMAL LIFE OF MOTOR. PRESS FIT ON SHAFT ELIMINATES NEED OF LOCK NUTS AND WASHERS. SLEEVE BEARINGS ALSO AVAILABLE.

CAST ***End Brackets*** WITH INTEGRALLY-CAST BEARING HOUSINGS PROVIDE RIGID SUPPORT FOR ROTOR, ASSURE PROPER SHAFT ALIGNMENT THROUGHOUT LIFE OF MOTOR.





COMPLETE ROTOR IS DYNAMICALLY BALANCED AFTER ASSEMBLY TO GUARANTEE SMOOTH, QUIET OPERATION.

HEAVY, CROSS-WELDED, FORMED STEEL FEET PROVIDE FIRM MOUNTING SUPPORT.

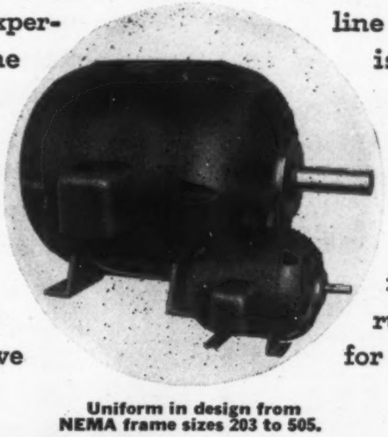
ALL VENTILATING OPENINGS ARE BELOW CENTERLINE. STURDY SHEET STEEL BAFFLE DIRECTS FLOW OF INCOMING AIR FOR MAXIMUM COOLING EFFECT.

CROSS SECTION VIEW OF BURKE TYPE NB INDUCTION MOTOR, FRAME 404

Burke Series "D" NEMA Frame Sizes 203 to 505.

Burke's new line of Drip-Proof Induction Motors follows our traditional policy of designing to generous proportions. We have achieved the utmost from NEMA frame standards utilizing over 30 years experience with welded steel plate frame construction. We have not tried to confine component parts into minimum space. As in all Burke motors we have designed for a generous factor of safety.

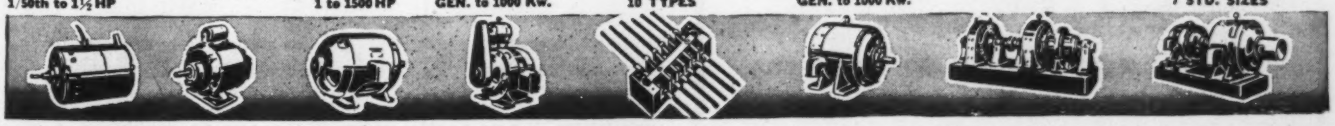
These Series "D" Motors on exhaustive tests in our plant have fully justified our generous-proportion-theory—they run exceptionally cool over extended periods of service. Note above that cooling air enters at each end below the centerline induced by rotor fan action, and is deflected up and down and around motor windings leaving thru large side openings between feet and below the centerline—no chance for recirculation. Here ample interior space for air-flow contributes to cool running. Write for bulletin D-1 for complete data.



Uniform in design from NEMA frame sizes 203 to 505.

BURKE ELECTRIC COMPANY 19712 W. 12th ST. ERIE, PA.

UNIVERSAL MOTORS 1/50th to 1½ HP
SINGLE PHASE MOTORS to ½ HP
INDUCTION MOTORS 1 to 1500 HP
SYNCHRONOUS MOTORS to 1500 HP GEN. to 1000 Kw.
TERMINAL BLOCKS 10 TYPES
D.C. MOTORS to 1500 HP GEN. to 1000 Kw.
M-G SETS to 1000 Kw.
HIGH CYCLE M-G SETS— 7 STD. SIZES

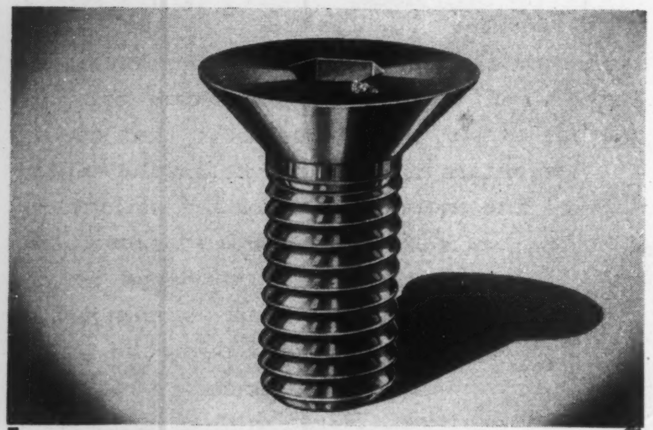


SOCKET SCREWS
FIBRO
TRADE MARK
FORGED

Completely Cold Forged

by

HOLO-KROME



NEWEST MEMBER of the HOLO-KROME FAMILY

FLAT HEAD SOCKET CAP SCREWS

Another achievement of the Holo-Krome exclusive, patented Completely Cold Forged method. Standard in the following diameters: Nos. 4, 6, 8, 10, ¼, 5/16, ⅜, 7/16, ½, ⅝, ¾. . . Your Holo-Krome Distributor will gladly serve you from his warehouse stock.

Design and Production Engineers quickly evaluate the many advantages of Holo-Krome FIBRO FORGED Socket Screws—the Completely Cold Forged Screws. Foremost among the advantages is increased strength. This is assured by the H-K patented method which maintains the inherent continuous fibrous structure thru every step in production. No drilling, broaching or extruding, they're Completely Cold Forged—a Holo-Krome exclusive! . . . Ask your H-K Distributor, he knows.

HOLO-KROME

fibro forged
TRADE MARK

INTERNAL
SOCKET SCREWS
WRENCHING

THE HOLO-KROME SCREW CORP., HARTFORD 10, CONN., U. S. A.

Specialists in Manufacturing to Customers' Specifications

OHIO RUBBER CO

Better Results with Rubber thru Research and Engineering

Typical Products Made for Industry Everywhere in the U.S.A.

AUTOMOTIVE PARTS

- Boots
- Bumpers
- Channels
- Fender Guards
- Gaskets
- Grommets
- Mats: Contour
- Mats: Flat
- Mats: Carpet Inserted
- Pedal Pads
- Running Boards
- Sill Mats
- Step Plates
- Tubing
- Weatherstrips
- Wiper Blades

RUBBER-TO-METAL

- Beater Bars (Farm Mch'y)
- Bumpers
- Pedal Pads
- Running Boards
- Sill Mats
- Step Plates
- Tractor Shoe Blocks

RUBBER BONDED TO:

- Aluminum 2S and 3S
- Black Iron
- Brass 70/30, or less
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- Cadmium Plate
- Cast Iron
- Chromium Plate
- Copper
- Dow Metal
- Galvanized Iron
- Lead
- Stainless Steel
- Terne Plate
- Zinc
- Carbon
- Wood
- Fibre (Vulcanized)
- Celotex
- Glass
- Plastics

HOSE (All Rubber)

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- Heater
- Washing Machine

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- Gaskets
- Grommets
- Gun Recoil Pads
- Laminated Door Panels for Refrigerators
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- Small Hard Rubber Parts
- Treadles
- Valve Cups
- Valve Discs

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- Tiring
- Tubing
- Weatherstrips

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Full range for length and O.D.

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- Engine
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All sizes and shapes to customer's specifications

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- Control Rod
- Fishing Rod
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- Motorcycle
- Outboard Motor
- Scooter
- Tricycle
- Tubular
- Vacuum Sweeper
- Velocipede
- Wagon

SEALS

- Dirt
- Grease
- Oil
- Silicone
- Water Pump

WHEELS

- Casters (Light Duty)
- Casters (Heavy Duty)
- Industrial Wheels (Molded and Pressed)
- Toys

TIRES
(Solid Molded)

- Automobile (Junior)
- Baby Carriage
- Caddy Cart (Golf)
- Coaster Wagon
- Garden Cart
- Hand Trucks, Etc.
- Industrial Vehicles
- Lawn Mower
- Misc. Portable Equipment
- Scooter
- Toy
- Velocipede

AIR KING TIRES
(Semi-Pneumatic)

Light Duty

Sizes from 8" x 1.25" to 20" x 1.75"

Typical Applications:

- Automobiles (Junior)
- Baby Carriages
- Caddy Carts (Golf)
- Coaster Wagons
- Garden Carts
- Hand Trucks, Etc.
- Industrial Vehicles
- Lawn Mowers
- Misc. Portable Equipment
- Scooter • Toys
- Velocipedes

Heavy Duty

Sizes from 6" x 2.00" to 16" x 4.00" with respective load ratings from 150 lbs. to 625 lbs. Other sizes and load ratings made to specifications.

Typical Applications

- Aisle Marking Machines
- Arc Welding Machines
- Barrel and Drum Trucks
- Battery Charging Machines
- Car Washers
- Contractors' Pumps
- Cooling Fans
- Floor Sweeping Machines
- Hand Trucks
- Hospital Equipment
- Insecticide Sprayers
- Lubricating Equipment
- Paint Sprayers
- Tote Trucks
- Traffic Line Markers
- Sidewalk Snow Plows
- Wheelbarrows
- Misc Portable Equipment

TIRES
(Extruded Tubing)

- Automobile (Junior)
- Baby Carriage
- Caddy Cart (Golf)
- Coaster Wagon
- Garden Cart
- Hand Trucks, Etc.
- Industrial Vehicles
- Lawn Mower
- Misc. Portable Equipment
- Scooters • Toys
- Velocipede

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FACTORIES: WILLOUGHBY, OHIO • LONG BEACH, CALIF. • CONNEAUTVILLE, PA.
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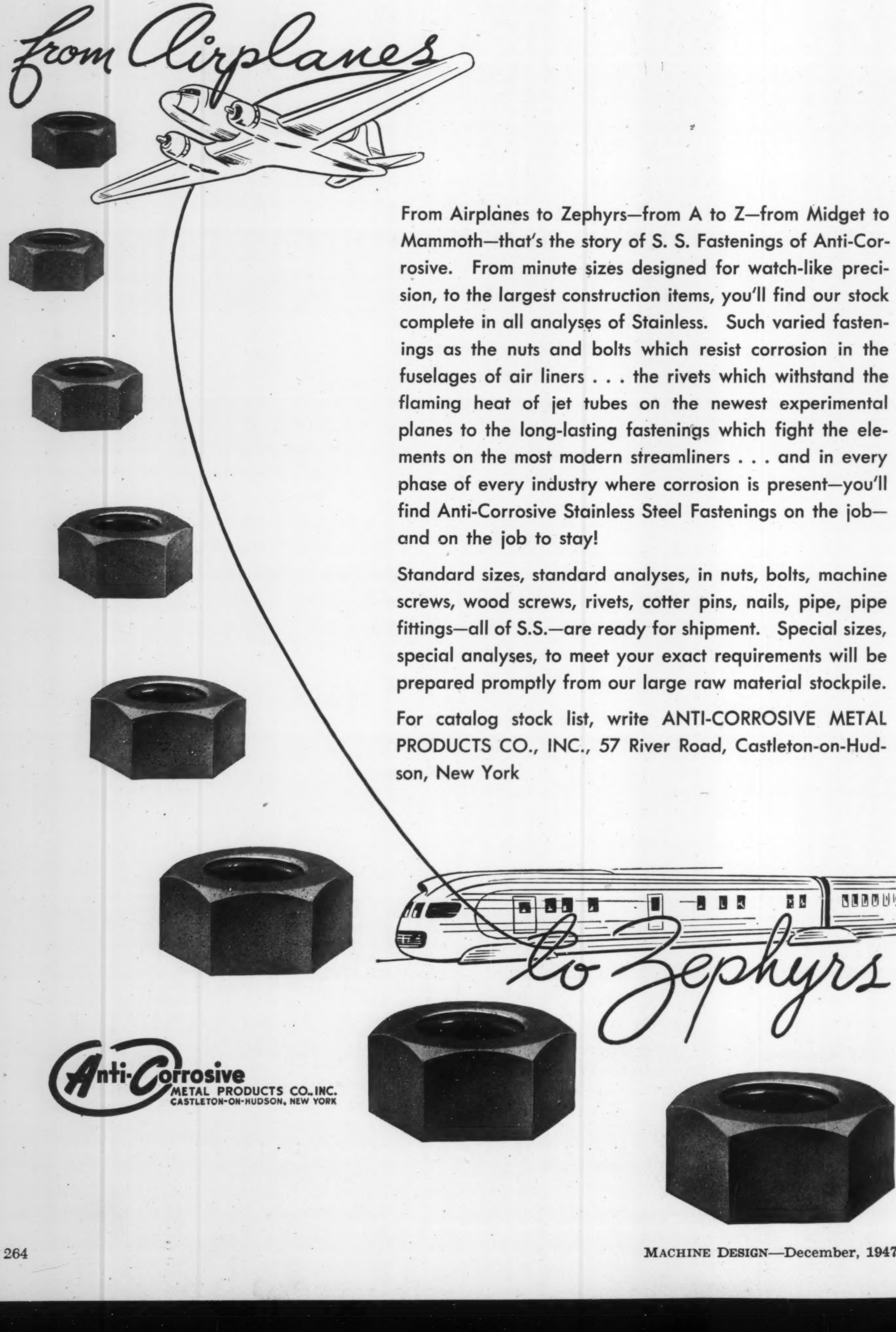

From Airplanes to Zephyrs—from A to Z—from Midget to Mammoth—that's the story of S. S. Fastenings of Anti-Corrosive. From minute sizes designed for watch-like precision, to the largest construction items, you'll find our stock complete in all analyses of Stainless. Such varied fastenings as the nuts and bolts which resist corrosion in the fuselages of air liners . . . the rivets which withstand the flaming heat of jet tubes on the newest experimental planes to the long-lasting fastenings which fight the elements on the most modern streamliners . . . and in every phase of every industry where corrosion is present—you'll find Anti-Corrosive Stainless Steel Fastenings on the job—and on the job to stay!

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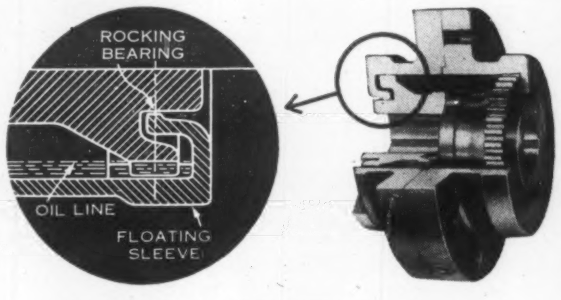
For catalog stock list, write ANTI-CORROSIVE METAL PRODUCTS CO., INC., 57 River Road, Castleton-on-Hudson, New York

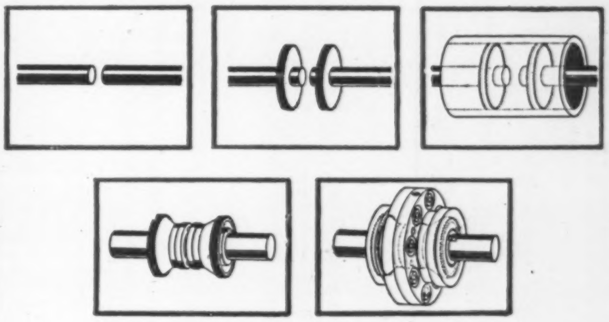
Anti-Corrosive
METAL PRODUCTS CO., INC.
CASTLETON-ON-HUDSON, NEW YORK



HERE'S HOW FAST'S Eliminates Perishable Parts!

No matter which type of Fast's Coupling you use, you can be sure of this . . . it will be all-steel throughout . . . without a single perishable part! As an example, the exclusive "rocking bearing," shown above, provides a positive metal-to-metal seal to protect the load-carrying oil against moisture, dust and grit. No perishable packing rings are used. There's nothing to wear, nothing to fail.

❶

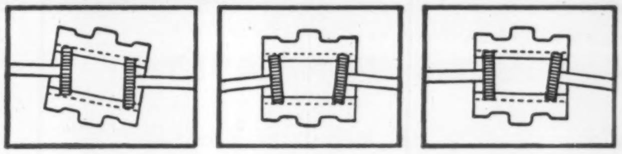


HERE'S HOW FAST'S Are Constructed—Simple as A-B-C!

See the simple development of Fast's self-aligning Couplings. A splined hub on each shaft end. A sleeve with internal splines to mesh. Oil in the sleeve, kept between the splines by centrifugal force, carries the load between the splines.

❷

These Facts About the ORIGINAL Gear-Type Coupling *Can Save You Costly Coupling Shutdowns*



HERE'S HOW FAST'S COUPLINGS Compensate for Misalignment!

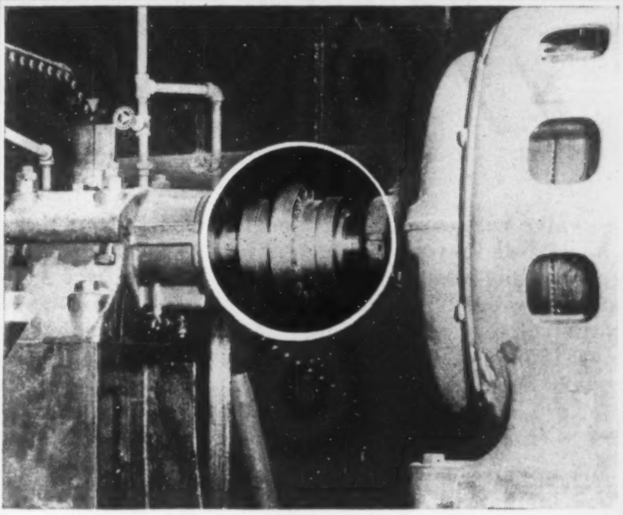
The floating sleeve takes a neutral position. All forms of misalignment are compensated for between the lubricated faces of the splines, equally divided between the driving and driven members. The entire assembly revolves as one unit.

❸

WE HAVE *a complete line of couplings for immediate delivery. Get full details on Fast's Couplings now by writing for our complete catalog. Just drop a line to:* Koppers Co., Inc., Fast's Coupling Dept., 352 Scott St., Baltimore 3, Md.

K
KOPPERS

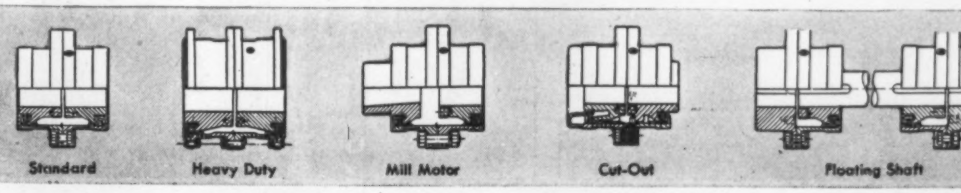
FAST'S *self-aligning* COUPLINGS



HERE'S HOW FAST'S COUPLINGS ARE USED

This No. 4 Fast's Coupling, connecting a motor and induced draft fan at the West Penn Power Company's Beach Bottom, W. Va., plant, is a good example of the way industry uses Fast's Couplings for uninterrupted power transmission. When you buy Fast's Couplings, you buy years of top engineering experience, Koppers' high standard of workmanship and unexcelled coupling service. Result: longer machine life, lower upkeep costs, minimum shutdown losses.

❹



OTHER TYPES:
Light Duty
Jordan
Single Engagement
Shear Pin
Breaking Pin
Continuous Lubricating
Collector Ring
Vertical

DESIGN FOR
Never..

RISK YOUR PRODUCT'S REPUTATION ON A "VALVE-IN-A-POKE"

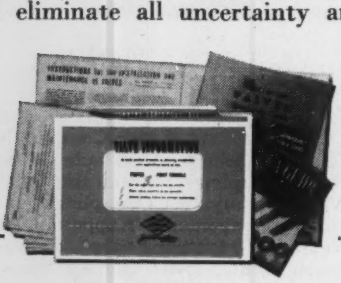
A valve carelessly chosen and installed in your product is literally a "pig-in-a-poke." You never know how much it will cost you in excessive servicing expense. You never know, either, how much damage its faulty operation will do to your product's reputation, no matter how well made otherwise.

When you choose Jenkins Valves, you eliminate all uncertainty and risk. You give your product the advantage of Jenkins' 83-year reputation for supplying valves of top-rated construction and performance. You know that you have selected the right patterns and placed them correctly in the assembly, because you can add the valve know-how of Jenkins Engineers, whenever necessary, to your own designing skill.

Finally, you gain a definite sales advantage for your product by using Jenkins Valves. Your prospects, noting the famous Jenkins Diamond and Signature Trade Mark, will have confidence in an equally high quality of construction throughout your product.

When planning new products or redesigning present equipment requiring valves, why not give your product and its purchasers the *extra value* of Jenkins Valves . . . *it costs no more.*

Jenkins Bros., 80 White Street, New York 13; Bridgeport, Conn.; Atlanta; Boston; Philadelphia; Chicago; San Francisco. Jenkins Bros., Ltd., Montreal.



GET JENKINS DESIGNERS' KIT. A handy file of valve information especially selected for product development men — helps answer the question — "*Which type of valve where for best performance?*" Mail the coupon.

JENKINS BROS., 80 White St., New York 13

Please send me the Jenkins Designers' Kit.

Name...

Company...

Address...

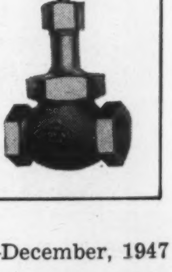
LOOK FOR THIS DIAMOND MARK

TRADE JENKINS MARK

SINCE 1864

Jenkins Bros

JENKINS VALVES



Types, Sizes, Pressures, Metals for Every Need

For MACHINE TOOL USERS AND PRODUCT DESIGNERS
ELECTRICAL vs. H
CARBIDE-CUTTING TOOLS
NEGATIVE RAKE
REDUCE SHAFTS AND GEARING
SAVE FLOOR AREA
SIMPLIFIED DESIGN
REDUCED WEIGHT
INDEXING
OIL VAPOR

Fiberglas* helps solve design problems

Designers and engineers are continually searching for ways to improve and refine their products. Time and time again, Fiberglas, in its many forms, plays an important part in this search.

For example, Fiberglas Electrical Insulating Materials have enabled machine tool designers and engineers to obtain smaller motors, motors with higher reversal capacity, less weight and greater power. Also, important savings in over-all floor space are possible and motor-mounting problems simplified where space is restricted.

If you have a problem in design . . . investigate the advantages of Fiberglas Electrical Insulating Materials as outlined in our new booklet, "For Machine Tool Users Only". It gives you all the facts about Fiberglas-insulated machine tool motors. Mail the coupon today for your copy. It may suggest an answer to some of your design problems. Or, if you are working on products in which the specific uses listed below are concerned, check the item for complete information.

OWENS-CORNING
FIBERGLAS
TM. REG. U.S. PAT. OFF.

***Fiberglas is the trade-mark (Reg. U.S. Pat. Off.) for a variety of products made of or with glass fibers by Owens-Corning Fiberglas Corporation.**

Owens-Corning Fiberglas Corporation, Dept. 808
Toledo 1, Ohio.

☐ Send me without obligation a copy of "For Machine Tool Users Only".

I would like to have further information on Fiberglas for:

- ☐ Electrical Insulation
- ☐ Thermal Insulation (High Temperature)
- ☐ Thermal Insulation (Low Temperature)
- ☐ Acoustical Insulation
- ☐ Air Filtration
- ☐ Fabrics—non-combustible, acid-resistant
- ☐ Fabrics—coated
- ☐ Plastics Reinforcement

Name..........................(Title)..................

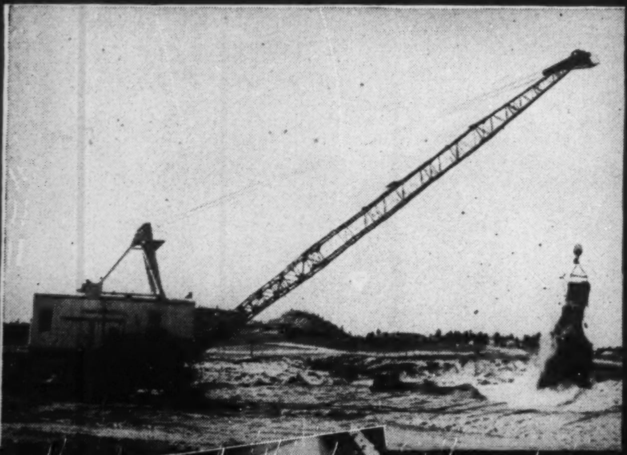
Company...

Address...

City..........................Zone......State...........

For ANY heavy duty service

USE FAWICK CLUTCHES

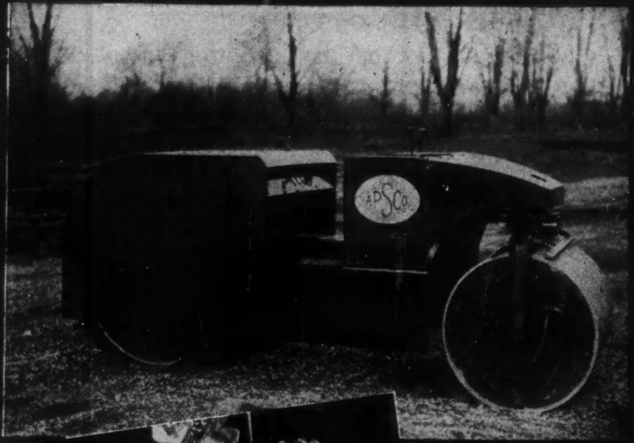


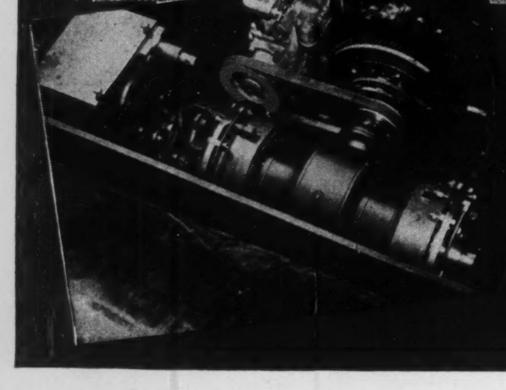
This 350-ton, 8 yard Marion drag line equipped with Fawick 84″ drag-drum clutch and 60″ Fawick hoist drum clutch.

Here are the moneysaving advantages of the Fawick Airflex Clutch for all types of heavy-duty clutch service:

1. Torque controlled and shocks absorbed by a cushion of air.
2. No strain on any part of machine in quick starts and stops under load.
3. No arms, lever or springs to wear or break.
4. No adjustments to make—no lubrication required.
5. Maintenance costs unusually low.
6. Entire machine protected against needless loss of productive time.

Let our Engineering Department give you our recommendations.





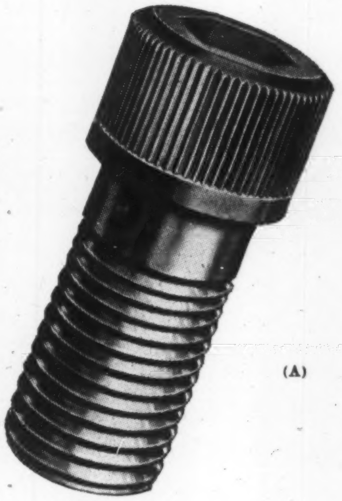
3 to 4-ton tandem roller, made by All-Purpose Spreader Co., equipped with Fawick 6″ drive clutches.

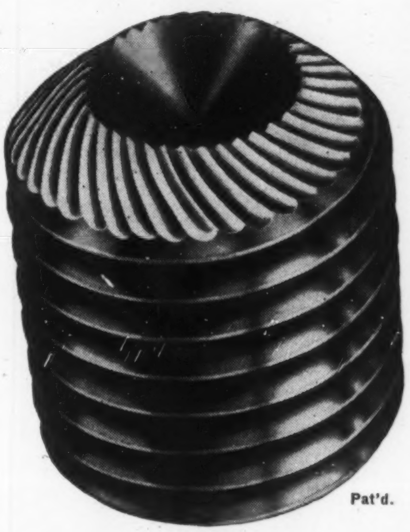
FAWICK Air flex CLUTCH

FAWICK AIRFLEX COMPANY, INC.
9919 Clinton Road • Cleveland 11, Ohio

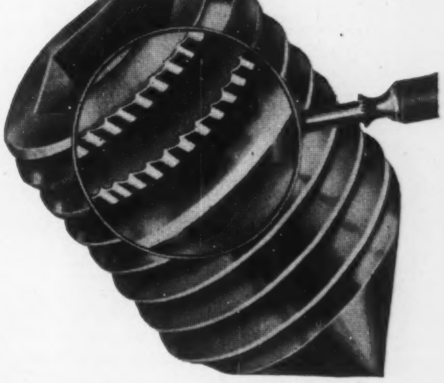
In Canada, Renold-Coventry Ltd., Montreal, Toronto, Vancouver
In Britain, Crofts Engineers, Ltd., Bradford, England

MILLIONS IN USE....
throughout industry


(A)


(B)

Pat'd.


(C)

UNBRAKO

Reg. U. S. Pat. Off.

Knurling of Socket Screws originated with "Unbrako" in 1934.

KITS: Pat.s Pend.

You can't tighten or loosen socket screws without a hex socket wrench, so why not get our No. 25 or No. 50 "Hallowell" Hollow Handle Key Kit which contains most all hex bits.

SOCKET SCREW PRODUCTS
KNURLING MAKES THE DIFFERENCE

(A) The *knurled* head of the "Unbrako" Socket Head Cap Screw, makes it slip- and fumble-proof— be the fingers and heads ever so oily—therefore, it can be screwed-in faster and farther before it becomes necessary to use a wrench, thereby helping to cut cost of assembly. The "Unbrako" Socket Cap Screw may also become a self-locker . . . ask us how!

(B) The *knurled* cup point of the "Unbrako" Socket Set Screw makes it a self-locker—because the point digs-in and *stays* dug—regardless of the most chattering vibration. Yet, it can be backed-out with a wrench and used again and again.

(C) The *knurling* of this "Unbrako" Socket Set Screw, as shown, swages the threads so it becomes a most excellent self-locker—for use where the points such as: flat, dog, cone and oval do not lend themselves to knurling.

Millions of these "Unbrako" Socket Screw Products—in sizes from No. 4 to 1½" in diameter and in a full range of lengths are being used throughout industry to save assembly time, facilitate compact designs, reduce weight and costs. Write for the "Unbrako" Catalog—very interesting and *informative*.

"Unbrako" and "Hallowell" Products are sold entirely through Industrial Distributors.

OVER 44 YEARS IN BUSINESS

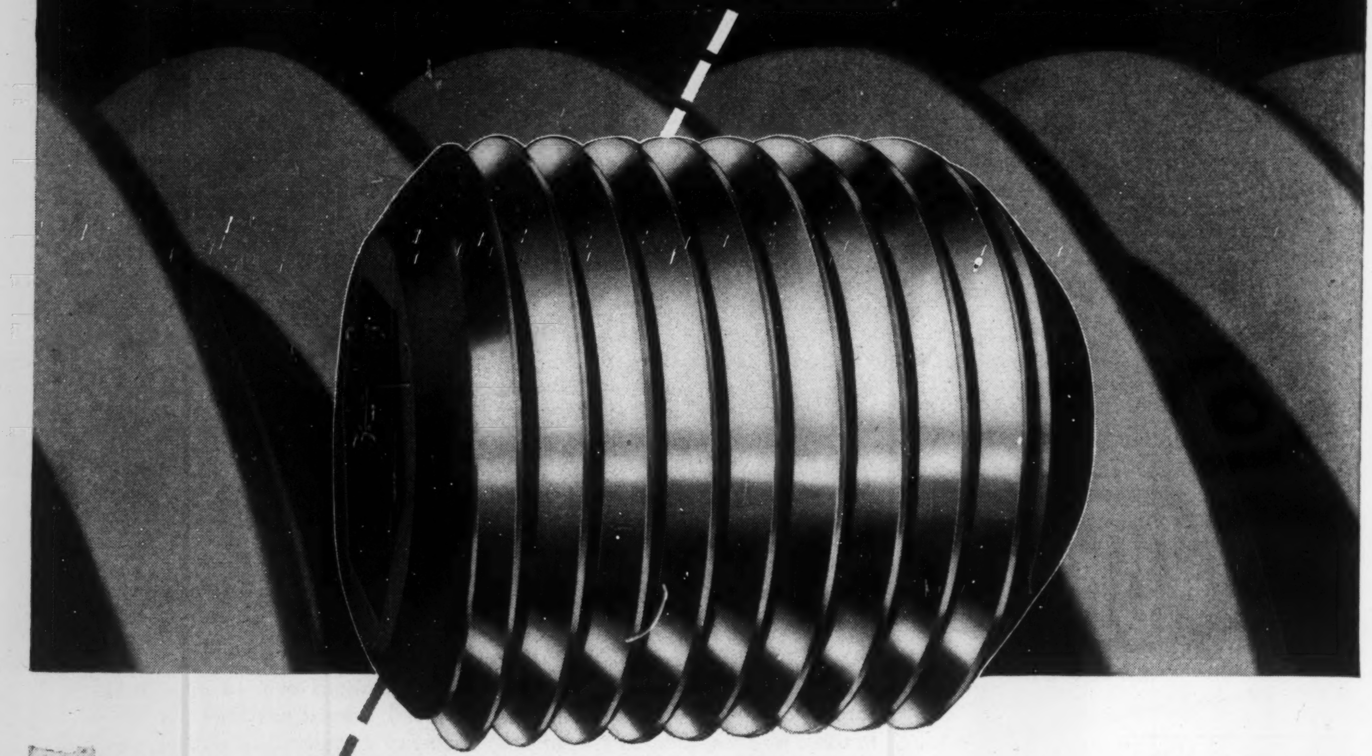
STANDARD PRESSED STEEL CO.

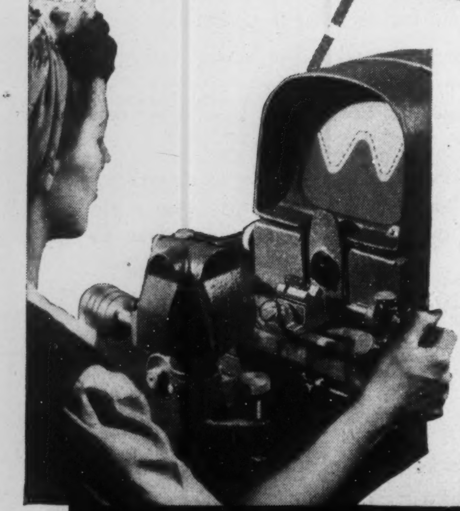
JENKINTOWN, PENNA., BOX 102 • BRANCHES: BOSTON • CHICAGO • DETROIT • INDIANAPOLIS • ST. LOUIS • SAN FRANCISCO

You're O.K. with P-K for Dependable

CLASS 3 FIT

in GROUND THREAD Socket Set Screws





THE COMPARATOR, used in inspecting every lot of P-K Ground Thread Socket Set Screws, clearly shows why you can be sure of uniform, dependable Class 3 Fit. Threads are ground on hardened blanks, by the first successful quantity production thread grinding process, with many advantages offered first in Socket Set Screws by Parker-Kalon.

Free from hardening distortion, mirror smooth, they have none of the nicks, burrs and other imperfections common to cut threads.

SEE AND FEEL THE DIFFERENCE! Ask for samples. See why P-K Ground Thread Socket Set Screws are years ahead by every test . . . why they'll put your product out in front — assembly-wise and sales-wise. Parker-Kalon Corp., 200 Varick St., New York 14.

Available for Prompt Delivery

SIZE-MARKED GEAR GRIP SOCKET HEAD CAP SCREWS

Another P-K First

PARKER-KALON *COLD-FORGED* **SOCKET SCREWS**

SOLD ONLY BY ACCREDITED DISTRIBUTORS

Steel-Weld FABRICATION

This welded base, produced for the Buell Die & Machine Co., is typical of the superior workmanship turned out by the Mahon organization. Complete, ultramodern facilities for producing, normalizing, stress analyzing, sand blasting, machining and painting, backed up by a staff of thoroughly competent design engineers and highly skilled craftsmen, are your assurance of a better, smoother-appearing job embodying every advantage of Steel-Weld Fabrication.

THE R. C. MAHON COMPANY
Detroit 11, Michigan

Engineers and Fabricators of Welded Steel Machine Bases and Frames, and Many Other Welded Steel Products

MAHON

This

CLARK TRUCLOADER

gives uninterrupted, dependable service, thanks to

RBC CYCLOPS BEARINGS

CLARK
CLARK FORK TRUCK
Kellogg's RICE KRISPIES
536

RBC CYCLOPS BEARINGS take the radial load in the chain sprockets and thrust rollers in the loader pictured above, which is manufactured by Clark Tructractor, a division of Clark Equipment Co.

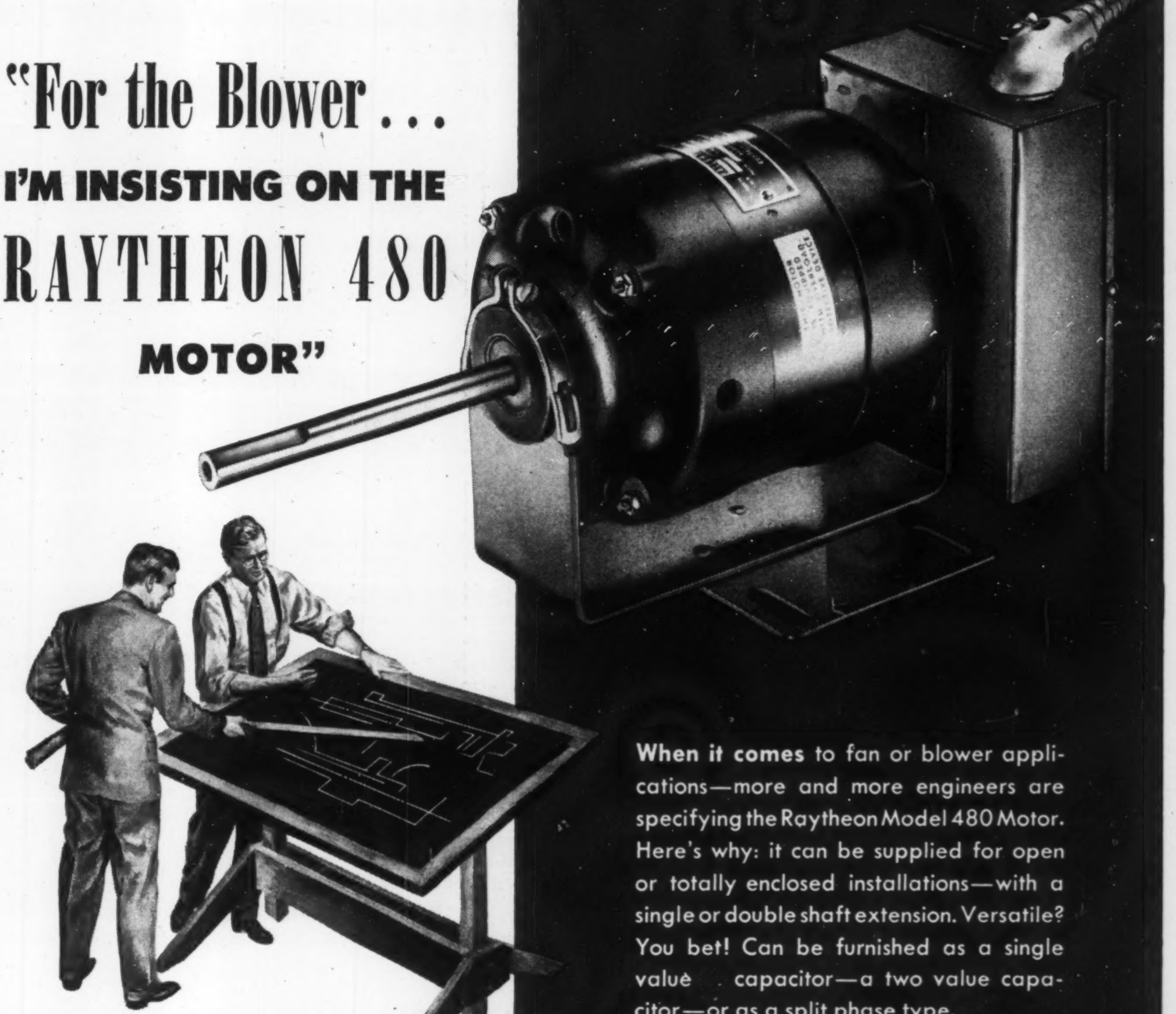
These bearings are strictly a quality product, being made of SAE 52100 steel, hardened throughout. They were developed through years of research in an effort to produce bearings that would meet all requirements for maximum load-carrying capacity in minimum space. The outstanding record of service built up in connection with equipment like that above is sufficient evidence that **RBC** BEARINGS meet the need.

CALL ON RBC ENGINEERS TO HELP YOU SOLVE YOUR DESIGN PROBLEM

ROLLER BEARING CO. OF AMERICA
TRENTON, NEW JERSEY

"For the Blower . . .
I'M INSISTING ON THE
RAYTHEON 480
MOTOR"

RAYTHEON MOTORS FOR SPECIAL APPLICATIONS supplied in H. P. ratings from 1/30 to 1/8. Single, also variable speeds from 1,100, 1,700 or 3,400 R.P.M.; Outside diameter—5"



When it comes to fan or blower applications—more and more engineers are specifying the Raytheon Model 480 Motor. Here's why: it can be supplied for open or totally enclosed installations—with a single or double shaft extension. Versatile? You bet! Can be furnished as a single value capacitor—a two value capacitor—or as a split phase type.

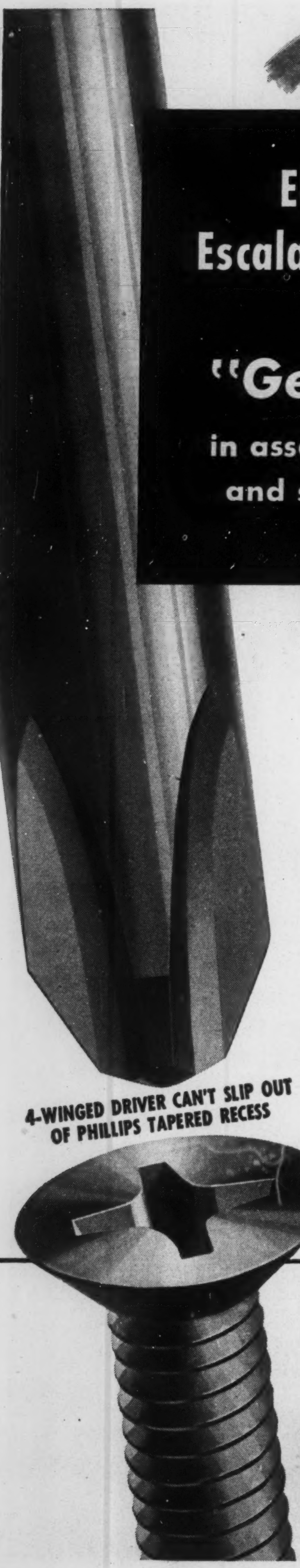
Balanced mechanical design—plus high efficiency and remarkably low noise level are features that add up to outstanding performance under the most challenging conditions. Tell us about your motor problem. We'll be glad to help you solve it!

RUSSELL ELECTRIC COMPANY

344 W. Huron Street • Chicago, Ill.

Elevator-Escalator Makers, too, "Get a Lift"

in assembly speeds
and sales appeal


4-WINGED DRIVER CAN'T SLIP OUT
OF PHILLIPS TAPERED RECESS

. . . when AMERICAN PHILLIPS SCREWS Fasten Better Faster!

Here's the PRODUCTION "LIFT" –Production goes up, cost goes down for elevator-escalator builders, appliance, furniture, auto and other manufacturers who assemble with fast fumble-proof, automatically straight-driving American Phillips Screws! This *maintained* speed means TIME SAVINGS UP TO 50%—with a bonus in no scars or work spoilage and added safety for workers.

Here's the SALES APPEAL "LIFT" –No burrs to catch hose or clothes with this smart, decorative, straight-set screw head that speaks quietly of solid construction from here on in—that's the American Phillips Screw. Why not get these competitive advantages in speed, sales and COSTS today? Write:

AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND
Chicago 11: 589 E. Illinois St. *Detroit 2:* 502 Stephenson Building

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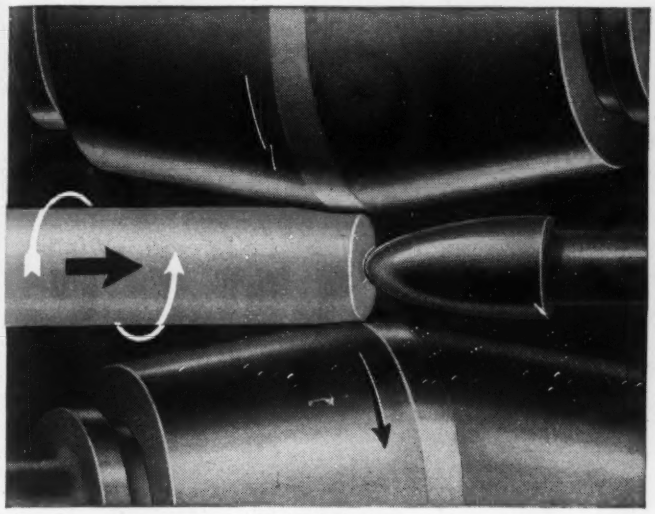
AMERICAN PHILLIPS *Screws*

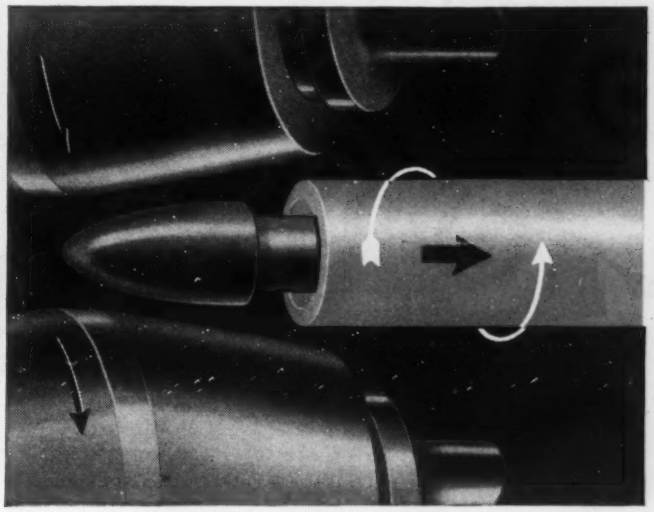
ALL TYPES
ALL METALS: Steel, Brass, Bronze, Stainless Steel, Aluminum, Monel, Everdur (silicon bronze)

No temperature drop during piercing

. . . another reason for the superior forged quality of Timken tubing



Billet enters mill



Pierced at rate of a foot a second

IF you make a hollow cylindrical part, chances are you can make it stronger, or cheaper—or both—with Timken seamless tubing.

During the piercing, which is basically a forging operation, Timken tubing is worked inside *and* outside. And because this forging action takes place at the rate of a foot a second there is no temperature drop while the metal is being worked. Result: uniform forged quality all through the finished tube.

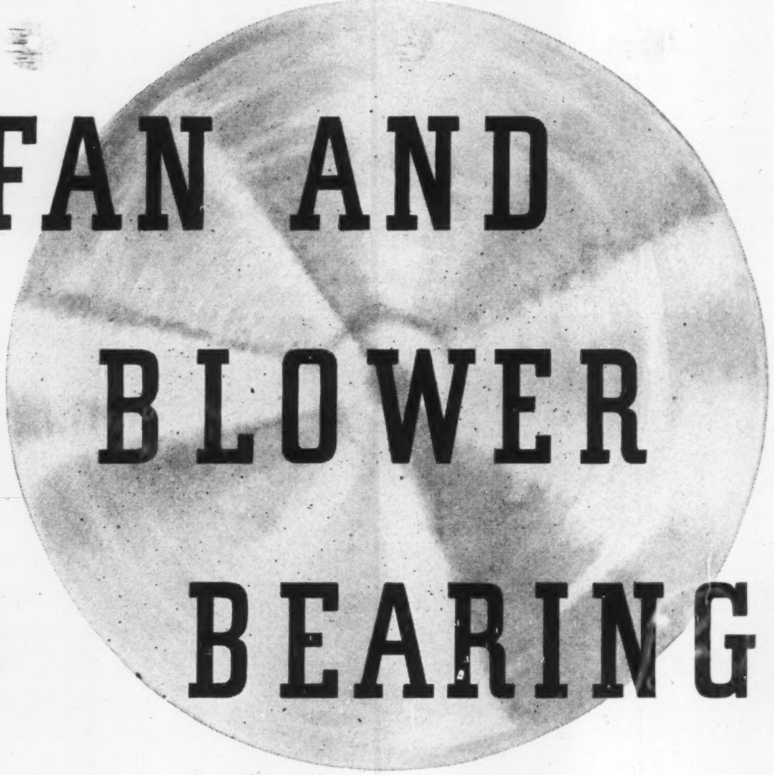
The metal displacement during the piercing of Timken tubing results in a denser structure, finer grain size and improved transverse grain flow. This means increased strength and ductility for any part made from Timken seamless tubing.

Uniformity from tube to tube and heat to heat is also assured because the Timken Company closely controls quality from melt shop through final inspection. And because Timken tubing can be inspected on the inside surface as well as the outside, your scrap losses are reduced.

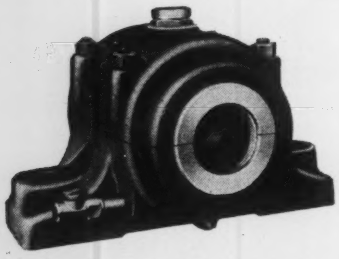
Many manufacturers of hollow cylindrical parts have increased strength and decreased cost with Timken seamless tubing. During the war, for instance, heavy duty gun barrels made from Timken tubing proved superior in strength yet cost far less than those made by conventional methods. Why not see if Timken seamless tubing can help increase the quality and decrease the cost of your product. Call on our Technical Staff for an on-the-job analysis. No obligation. Write Steel and Tube Division, The Timken Roller Bearing Company, Canton 6, Ohio.

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH
TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
Fine Alloy
STEEL
and Seamless Tubes

Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing.

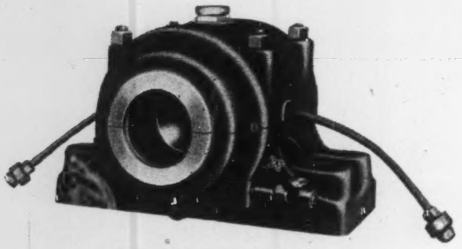


FAN AND BLOWER BEARINGS



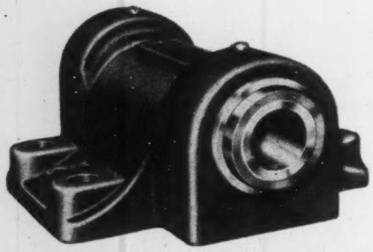
SLEEVOIL PILLOW BLOCK

A precision-built, ring-oiling babbitted bearing, self-aligning and exceptionally quiet. Special seals prevent oil leakage and keep dirt out. Field-proved by thousands of installations.



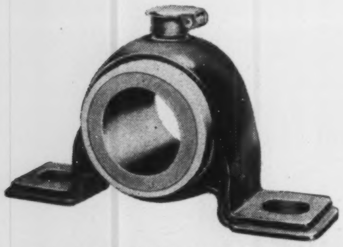
WATER-COOLED SLEEVOIL PILLOW BLOCK

Designed for applications where higher temperatures are encountered. Shaft sizes from 1-11/16" to 8". Widely used under industry's toughest operating conditions.



DH BALL BEARING FAN AND BLOWER PILLOW BLOCK

Single row, deep groove ball bearings for No. 2 arrangement. Inner race extended to form sleeve which carries shaft. Piston ring seals retain lubricant, exclude dirt. Shaft sizes 15/16" to 2-1/4". A favorite where compactness is at a premium.



BRONZOIL PILLOW BLOCK

Capillary bronze bushing has capacity of one-third its volume in oil. Reservoir with close fitting wick around bushing provides ample lubrication. Oil resistant and static proof grommets available for noise isolation. Sizes 1/2" to 1-1/4". America's standard for light applications.

Copyright, 1947, Dodge Mfg. Corp.

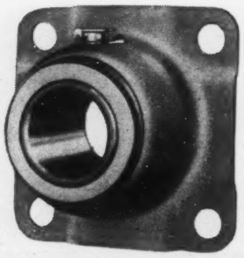
America's Most Complete Line

Working closely with air conditioning equipment manufacturers, Dodge of Mishawaka has developed bearings to meet the exacting operating conditions encountered in this industry. Cost-saving products for the mechanical transmission of power are manufactured by Dodge for use in all industries.

DODGE MANUFACTURING CORPORATION • MISHAWAKA, INDIANA

DODGE

of Mishawaka, Ind.



BRONZOIL FLANGED BEARING

Mounted in heavy gauge steel flanged housing this bearing has the basic Bronzoil construction and characteristics as described at the left. Sizes 1/2" to 1-1/4". A proven performer in a new mounting.

CALL THE TRANSMISSIONEER

your local Dodge distributor, for information about the line of Dodge bearings for fan and blower service—and for news about Dodge products to cut costs and increase production in all industries. Look for his name under "Power Transmission Equipment" in your classified phone directory.

NAME PLATES

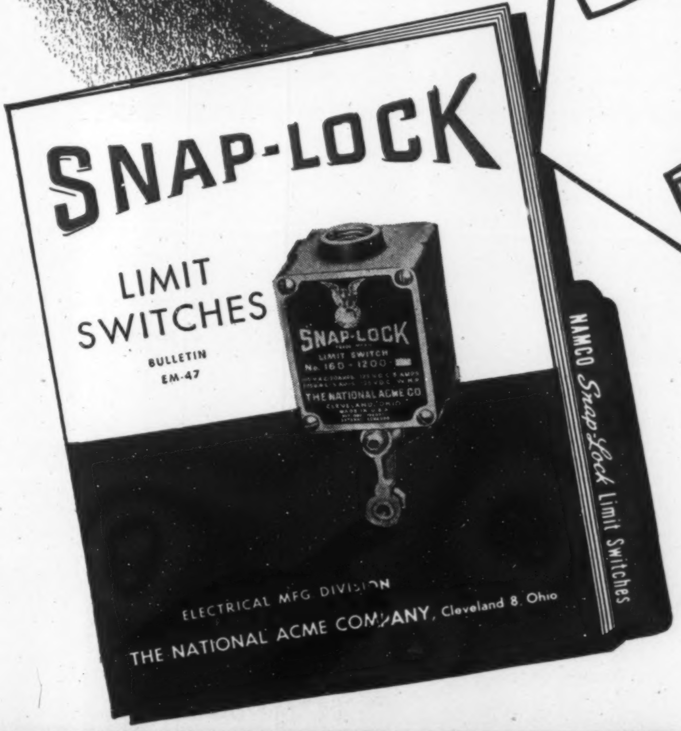
FOR YOUR NAME PLATE REQUIREMENTS, WRITE OUR SUBSIDIARY, ETCHING COMPANY OF AMERICA, 1520 MONTANA STREET, CHICAGO 14, ILLINOIS

How to Save

- **Operation Breakdowns** • **Space**
- **Expensive Mechanical Contrivances**
- **Operating and Equipment Costs**

WITH STANDARD NAMCO SNAP-LOCK LIMIT SWITCHES

Complete specifications in this new Bulletin EM-47


SNAP-LOCK
LIMIT SWITCHES
BULLETIN EM-47
SNAP-LOCK LIMIT SWITCH No. 160-1200
THE NATIONAL ACME CO. CLEVELAND, OHIO
ELECTRICAL MFG DIVISION
THE NATIONAL ACME COMPANY, Cleveland 8, Ohio
NAMCO Snap-Lock Limit Switches

Write

FOR YOUR COPY

The NATIONAL ACME CO.

170 EAST 131st STREET • CLEVELAND 8, OHIO

Acme-Gridley Bar and Chucking Automatics: 1-4-6 and 8 Spindle • Hydraulic Thread Rolling Machines • Automatic Threading Dies and Taps • The Chronolog • Limit, Motor Starter and Control Station Switches • Solenoids Centrifuges • Contract Manufacturing

STEP UP YOUR PRODUCTION... DECREASE YOUR COSTS

WITH **RHOADS**

Tannate-Rockwood

SHORT CENTER DRIVE

Tannate-Rockwood Short Center Drives—a reliable combination of Tannate Flat Leather Belt, Rockwood Pivoted Motor Base and Pulleys—assure constant, uniform speeds . . . higher hourly production . . . more uniform work . . . fewer shutdowns . . . and less wear on bearings and belt.

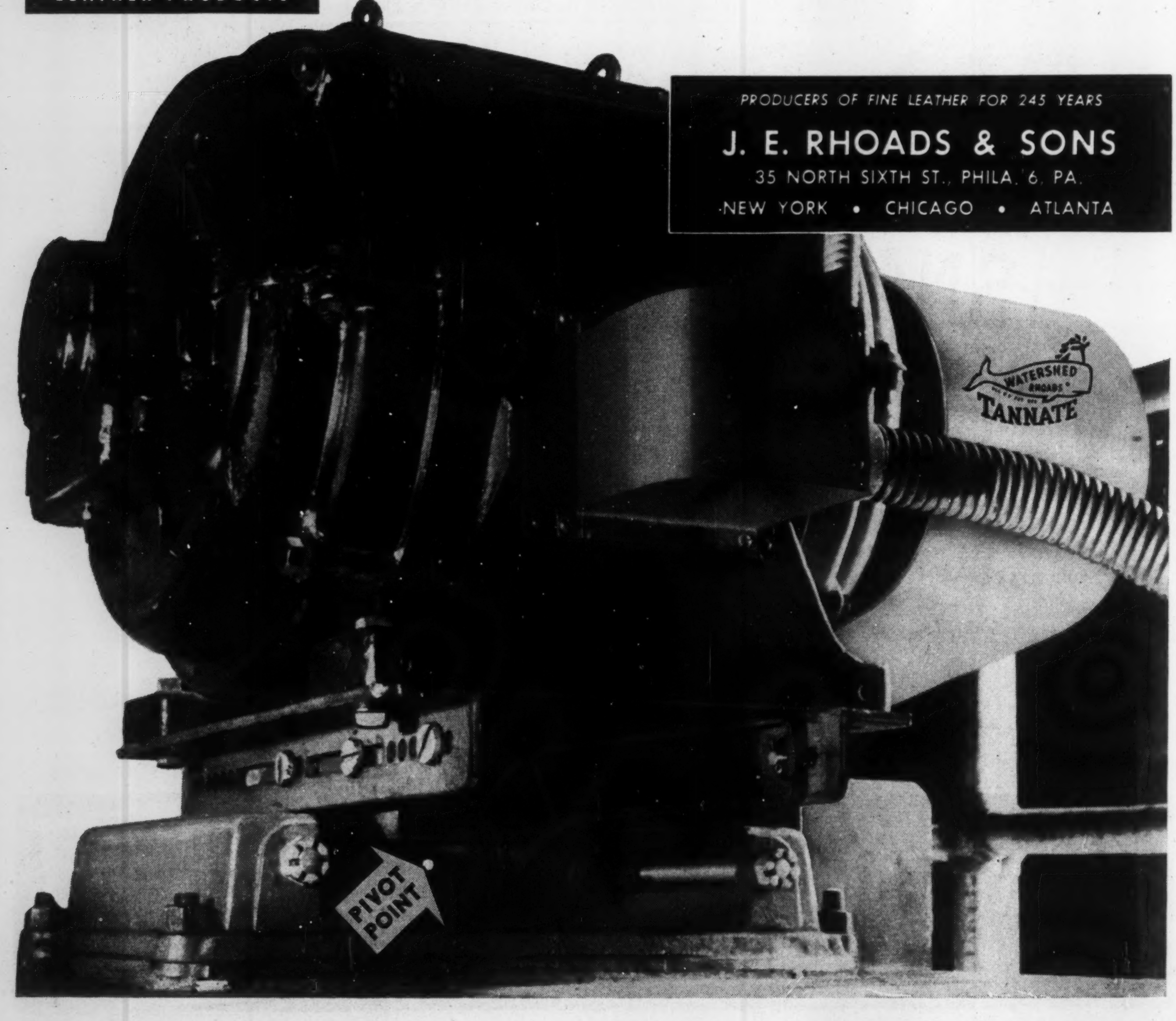
Tannate Flat Leather Belt provides long, trouble-free belt life; requires fewer take-ups and less maintenance; resists high temperatures, water, machine oils and many chemicals. Pivoted motor base automatically maintains correct belt tension regardless of load fluctuations.

Write for detailed information about this cost-reducing, production-increasing combination.

HYDRAULIC PACKINGS AND OTHER MECHANICAL LEATHER PRODUCTS

PRODUCERS OF FINE LEATHER FOR 245 YEARS

J. E. RHOADS & SONS
35 NORTH SIXTH ST., PHILA. 6, PA.
NEW YORK • CHICAGO • ATLANTA



The Security Manufacturing Company

OF KANSAS CITY, MISSOURI

• ...increased steel furnace drum production 733%

AIRCO TECHNICAL SALES SERVICE REPORT

PROBLEM: To speed up cutting of sixteen gauge steel panels in the fabrication of furnace burner drum extensions. The hand cutting operation in use was slow, and resulted in poor welding fit-up. Also, slag removal and straightening of distorted panels resulted in excessive time loss.

SOLUTION: We recommended stack cutting with an oxyacetylene flame-cutting machine—the Airco No. 10 Planograph. This machine cut a stack of 25 panels in the time formerly required to shape 3 by hand—increasing steel furnace panel production 733%. Further, no time was lost in cleaning or straightening ...and welding fit-up was perfect.

Since purchasing the Airco No. 10 Planograph, Security Manufacturing Company has found numerous other time-saving, cost-reducing cutting jobs around the shop, and, today, feels that this machine is one of its most profitable production tools.

A.O. Dodge
Airco Technical Supervisor

Airco's Technical Sales Division is at the call of all industry in applying Airco processes and products in the solution of their problems. If you have a metal working problem, ask to have a Technical Sales Division man call. Address: Dept. MD-6533, Air Reduction, 60 East 42nd St., New York 17, N. Y. In Texas: Magnolia Airco Gas Products Co., Houston 1, Texas.

AIRCO **AIR REDUCTION**

Offices in All Principal Cities

TECHNICAL SALES SERVICE—ANOTHER AIRCO PLUS-VALUE FOR CUSTOMERS

HOW TO TIGHTEN A SOCKET SCREW'S GRIP

...without safety wires

Specify BRISTO "Multiple-Spline"

Defying vibration that often shakes "hex" screws loose . . . speeding assembly of products with hard-to-reach fastening points . . . easing disassembly — BRISTO "Multiple-Spline" Socket Screws are now making a hit with many designers and production men.

BRISTO "Multiple-Spline" gets its tighter grip from the unique way the wrench, geared to the spline-shaped socket, pulls the screw around. No expanding pressure. No bursting or rounding out of socket walls. Yet, a flick of the wrench releases the deep-seated grip.

Literature describing BRISTO "Multiple-Spline" Socket Screws and their many applications is yours for the asking.

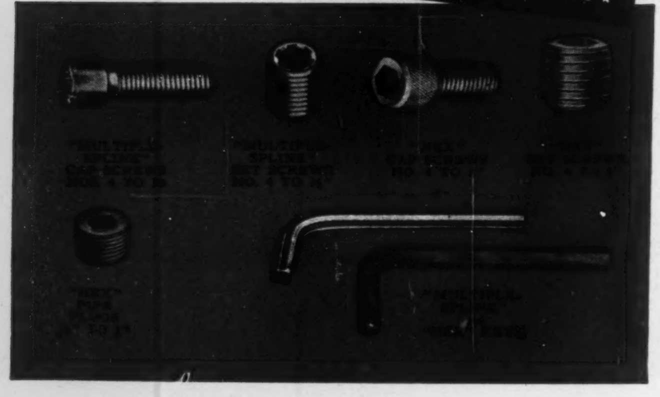
THE BRISTOL COMPANY, Mill Supply Division, 122 Bristol Rd., Waterbury 91, Conn.

WHY "MULTIPLE-SPLINE" MEANS **TIGHTER**
NO EXPANDING PRESSURE: THE KEY PULLS THE SCREW AROUND

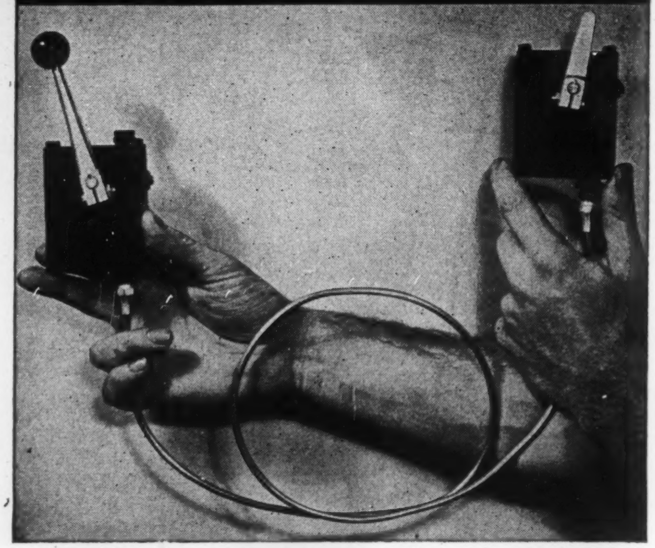
MULTIPLE SPLINE SOCKET BRISTO SET & CAP SCREWS

Only the "B-LINE" has the right socket screw for every application

The BRISTOL Company
MILL SUPPLY DIVISION



SPERRY
Single Tube HYDRAULIC SYSTEMS



Here's a tiny — almost miniature — Sperry Control System that's:

EASY-TO-INSTALL

A single flexible copper tube connects receiver and transmitter... does away with design limitations imposed by use of old-fashioned link rods and bell cranks, pulleys and control cables, etc.

EASY-TO-OPERATE

Balanced system permits operation with fingertip pressure — smooth, even action, without time lag, without backlash.

ACCURATE AND DEPENDABLE

Accuracy of ¼ of 1 degree through an effective operating arc of 60°. Water-proof, corrosion-resistant, dust-proof, it's as dependable as the larger units long manufactured by Sperry.

Write for Bulletin 2400-H or for information on your particular problem. SP-102

Dealer Inquiries are also invited.

SPERRY

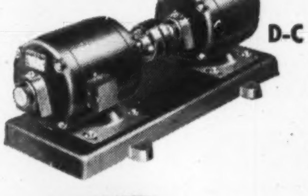
SPERRY PRODUCTS, INC.
15th Street & Willow Avenue
Hoboken, N. J.

Once Again General Electric Offers *Short Deliveries*

On D-C FHP Motors and Generators

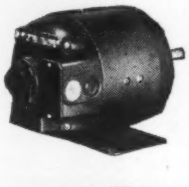
GENERAL-PURPOSE D-C MOTORS

Designed for general-purpose applications. Often used with a-c and d-c conversion equipment. Gives you quiet operation. Comes in wide range of horsepower ratings and speeds.



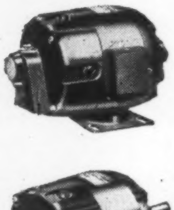
D-C GENERATORS AND MOTOR-GENERATOR SETS

Recommended as d-c power unit for industrial devices or as exciters for large equipment. Available in output ratings of 125, 250, and 500 watts continuous duty; 125 and 250 d-c volts.



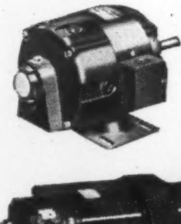
LOW-VOLTAGE SPECIAL D-C MOTORS

Operate from power sources commonly used on busses, trucks, railroad equipment, battery-operated industrial trucks, etc. Sturdy adaptable motors, built usually from general-purpose motor parts.



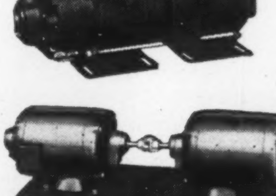
DYNAMOTORS

Give you reliable means of converting d-c power to other voltages, or to a-c. Recommended for neon signs, locomotive headlights, communication equipment, etc. A light but sturdy unit.



A-C GENERATORS

Offer you effective source of a-c current for places where it otherwise would be unobtainable. Available in standard ratings. Strong, well constructed power units.



MOTOR AMPLIDYNE-GENERATOR SETS AND AMPLIDYNE GENERATORS

Give unusually quick response over a wide range of operating loads. Thus, the amplidyne generators are suitable for many applications. Available in single units or assembled with motor drive.

HIGH-FREQUENCY MOTOR ALTERNATORS

Highly recommended for testing equipment and source of power supply for high-frequency machines. Small and lightweight units, but sturdy and hard-working.

It has been a long time since we have talked about short deliveries on fractional-horsepower motors. But our engineering and manufacturing facilities are now available to give you just that on d-c fhp motors, generators, and motor-generator sets. Whether you require a few motors or many, we are ready to help you.

Available for quick short deliveries are general-purpose d-c motors, d-c generators and motor-generator sets, low-voltage special d-c motors, dynamotors, a-c generators, motor amplidyne-generator sets and amplidyne generators, and high frequency motor alternators.

These equipments have a variety of applications. Our staff of experienced fractional-horsepower motor engineers can help you with design and application problems. These men accumulated a vast store of new "know how" from thousands of war jobs. Combine this with previous accumulation of design knowledge and application experience, and you have 46 years of experience at your service.

Whether it is a new or old application, we can help you. Save you time and money, too! For more information on the kinds of equipments we can offer you for quick delivery, write for GEA-4871, or call your nearest G-E office.

Mail This Coupon For Bulletin Describing Available D-c, Fhp Equipments

General Electric Company
Apparatus Dept., Section K700-84
Schenectady 5, N. Y.

Please send me bulletin, GEA-4871, which describes G-E d-c fractional-horsepower motors and generators available for short delivery.

Name..........

Company..........

Street..........

City.......... State..........

GENERAL ELECTRIC

700-84

PORTRAIT OF A

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BASED on original research and on practical applications, "Mechanical Springs" also includes results of investigations carried out under the direction of the American Society of Mechanical Engineers and the War Engineering Board Spring Committee of the Society of Automotive Engineers.

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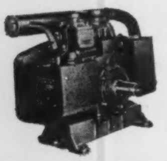
10 H. P. 4-CYCLE



Two-cylinder horizontal opposed design gives the new, heavy-duty CK engine unusual running smoothness. Short, rigid crankshaft . . . 2-inch diameter main and 1⅝-inch diameter rod bearings . . . pressure lubrication . . . axial-flow cooling fan . . . aluminum construction giving 4-to-1 cooling advantage over cast iron . . . weighs only 97 pounds and fits neatly into 15″ x 19″ x 18″ space. Designed to solve engine power problems in industry, agriculture and other fields. Proven by thousands in use today . . . now in mass production . . . prompt delivery.

Also has: Built-in precision governor . . . downdraft concentric carburetor for wide-angle operation . . . oil bath air cleaner . . . fuel pump . . . oil pressure gauge . . . crankcase fumes exhausted to carburetor . . . hermetically sealed magneto ignition coil with easy-to-get-at breaker points, 2-qt. oil capacity.

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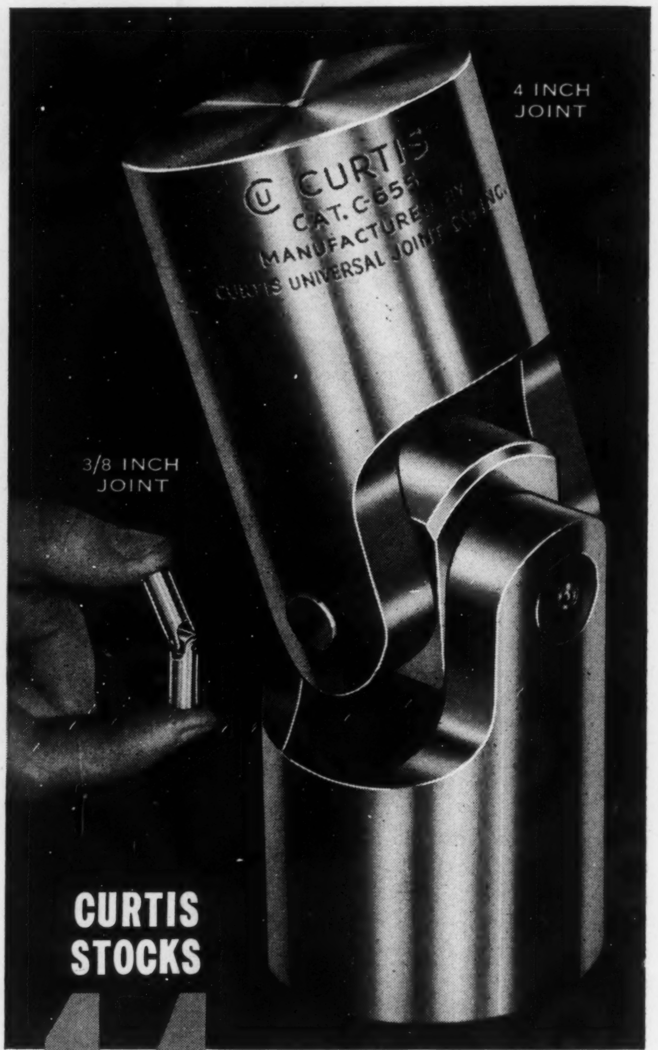

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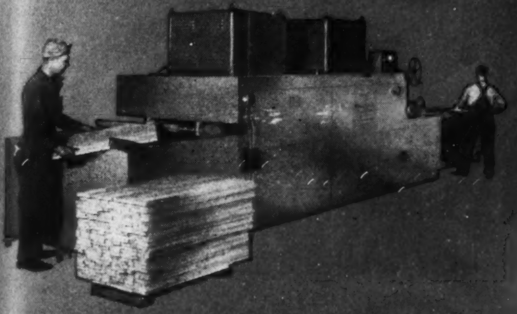
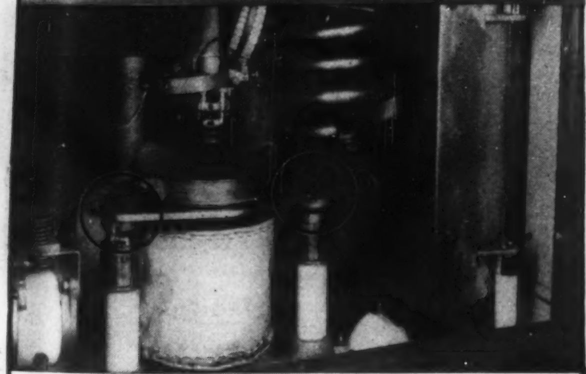
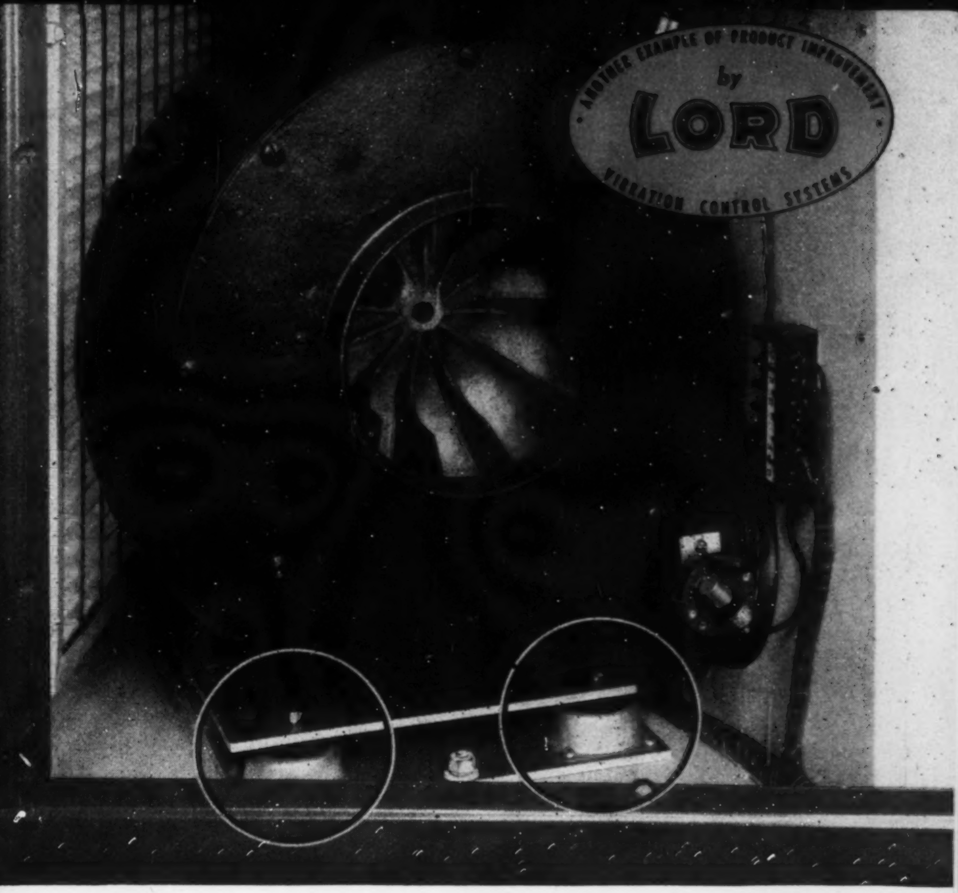
Isolates Blower
VIBRATION
with LORD
VIBRATION CONTROL
SYSTEM



Above—Thermex Model 10-H high frequency heat generator used for high speed wood-glue bonding. Lord Mountings isolate blower vibration from sensitive equipment.

Below—Lord Vibration Control System in Thermex Model 10-H also includes Mountings for oscillator tube. Complete protection prolongs tube life—cuts operating costs.




ANOTHER EXAMPLE OF PRODUCT IMPROVEMENT
by
LORD
VIBRATION CONTROL SYSTEMS

***LORD** Mountings Used by The Girdler Corporation in Thermex High Frequency Heating Equipment to Isolate Blower Vibration—Protect Oscillator Tube—For Greater Efficiency, Service Life . . .*

Greater efficiency—longer service life—smooth, quiet performance are obtained in Thermex high frequency heating units by thorough isolation of vibration. Protection of sensitive electronic equipment from vibration is so important that The Girdler Corporation, Thermex Div., specifies a *complete* Lord Vibration Control System in their product.

The Lord Vibration Control System in this Thermex unit provides two-way protection . . . first, by isolating blower vibration, and secondly—for complete protection—isolating the sensitive oscillator tube from external vibratory disturbances. Four Lord Shear-Type Bonded-Rubber Mountings under the blower and motor assembly prevent its vibration from damaging the oscillator tube. Three more Lord Mountings support the oscillator tube, effectively guarding it against shock and vibration from nearby machinery.

Whether you manufacture electronic equipment or any other product, you can increase your sales by eliminating costly, destructive vibration. It will pay you to consult Lord . . . make us your headquarters for product improvement through Lord Vibration Control Systems.

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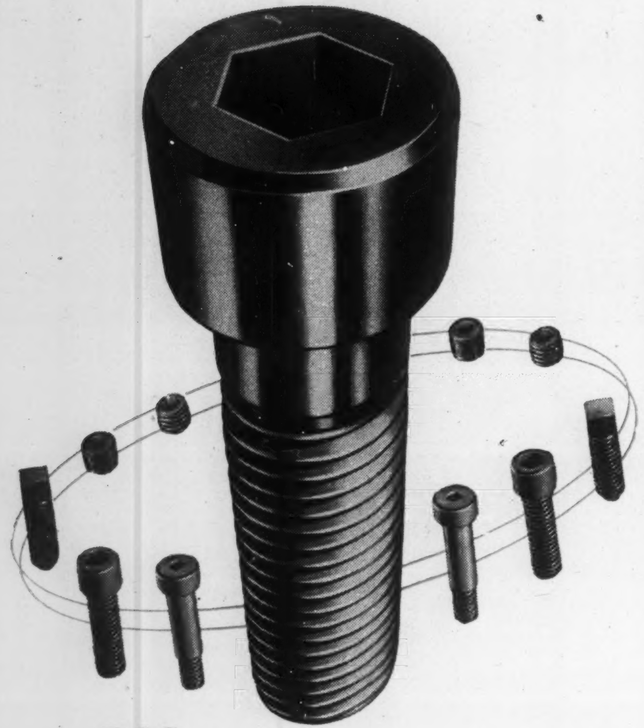

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Naturally, in the best interest of your products, fastenings should be as small and as light as possible while satisfactorily doing their job.

Chicago "Safety Plus" Socket Head Cap Screws are a high tensile, high IZOD fastening, smaller and lighter than ordinary hexagon head cap screws of equal holding power. Their use in your products means reduction in weight as well as a neater, sturdier construction.

The combination of manufacture from selected heats of alloy steel, precision workmanship and rigid inspection assures perfect uniformity for greater efficiency in your assembly. "Safety Plus" fastenings are the most economical in size and weight for your products.

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Socket Head Cap Screws • Socket Set Screws • Stripper Bolts • Square Head Dog Point Set Screws • Socket Pipe Plugs • Keys for "Safety Plus" Products.

Complete line includes:

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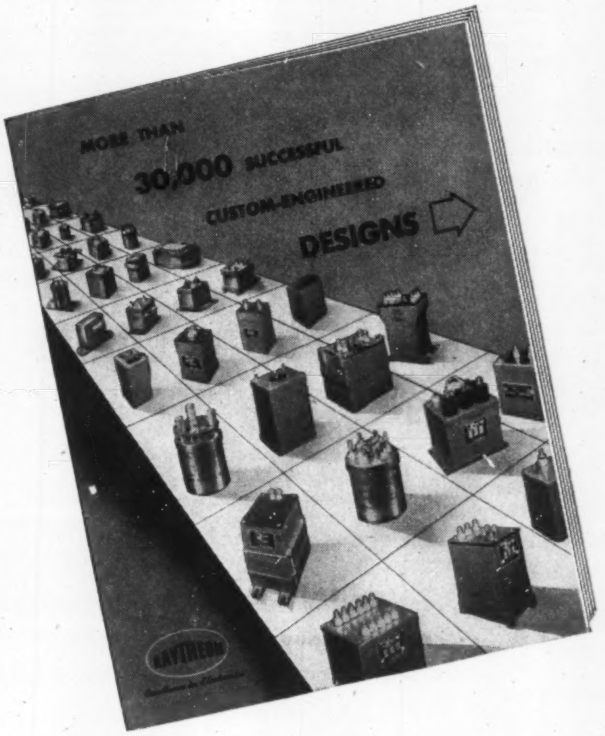

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Rubber plunger cups operating in porcelain lined cylinders, one of the unique design features of John Bean Pumps, reduce friction to a minimum . . . for equal capacities, John Bean Pumps run slower than either gear or rotary pumps.

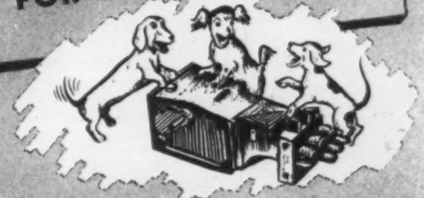
LONG WEAR!

The liquid ends of John Bean Pumps operate efficiently without requiring close tolerances. Abrasive solids in the fluid do not rapidly wear mechanism to the point of inefficiency.

EASY SERVICING!

The few operating parts of John Bean Pumps are easily accessible. When servicing is required, repairs can be made promptly without complete disassembly. Plunger cup packing leakage can be easily observed.

SPECIFY JOHN BEAN RECIPROCATING PUMPS FOR HYDRAULICS



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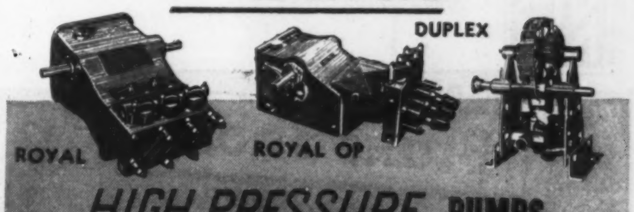

HIGH PRESSURE PUMPS

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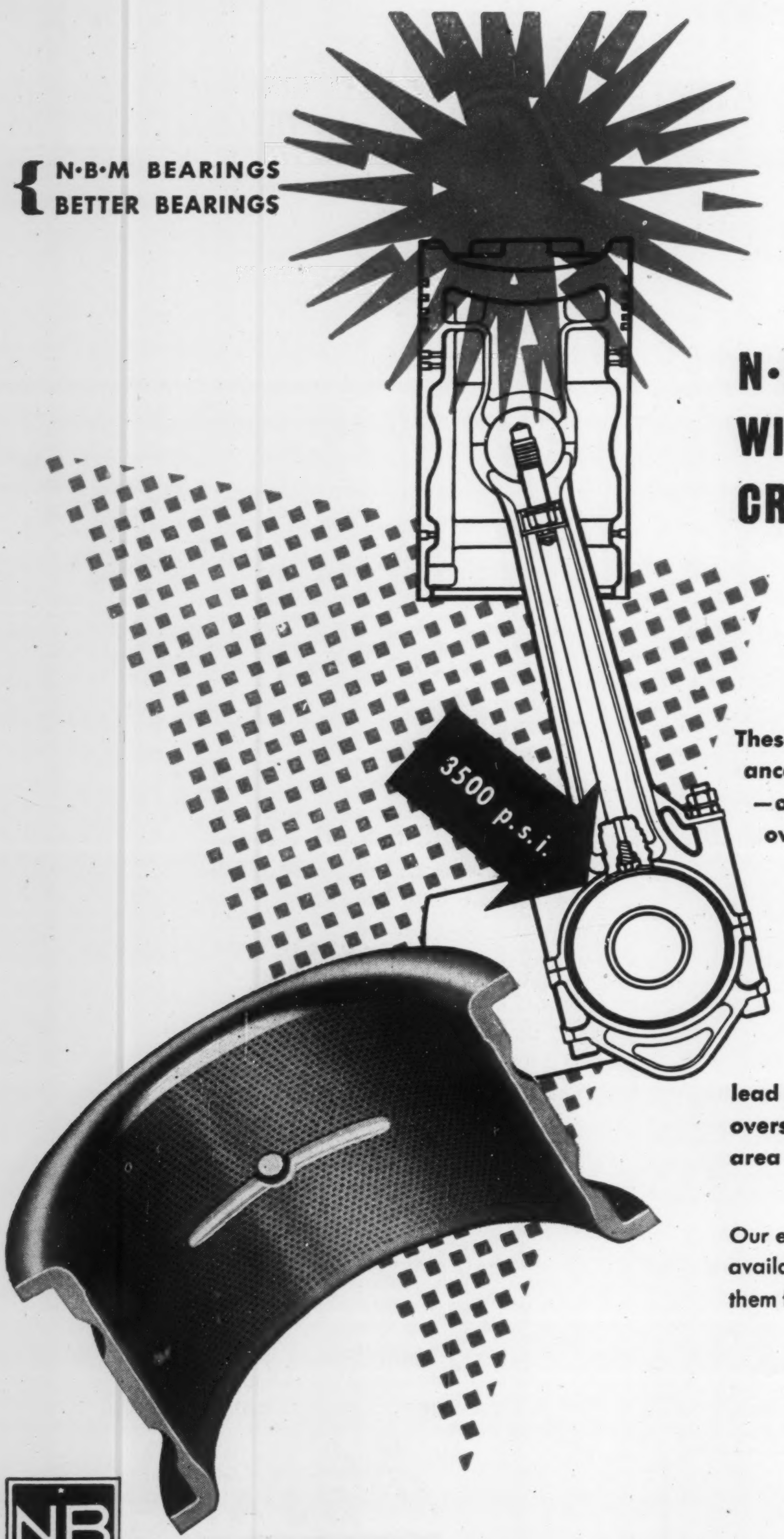
BETTER BEARINGS



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EXAMPLE:

These stress-defying bearings set new performance records in heavy-duty diesel engine service —operating in connecting rods under loads of over 3,500 p.s.i. projected area.

REASON:

N-B-M Gridded Bearings combine the *seizure resistance* and *embedability* of Silver Babbitt with the *fatigue strength* and *conformability* of centrifugally cast lead bronze. They are "self-healing": in case of overstress, melted babbitt flows over the critical area to prevent damage to shaft or bearing.

Our exclusive new manufacturing process makes them available at "mass-production" savings so you can use them freely. May we send complete engineering data?

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HELPFUL LITERATURE

FOR DESIGN EXECUTIVES

62. Spring Clutches

L. G. S. Spring Clutch Corp.—3-page illustrated bulletin describes spring clutches which are compact, can be engaged or disengaged under full torque, reverse instantly under full load, can be built into gear hubs and bearing mountings, and have automatic overload release without shear pin.

63. Induction Motors

Reliance Electric & Engineering Co.—4-page illustrated bulletin No. C-125 presents information on series C totally enclosed, fan cooled, type AA induction motors in squirrel cage frame sizes from 224 to 326 for operation on 2 and 3-phase alternating current circuits. All-steel frames, welded cores and pressure cast rotors are features.

64. Flexible Tubing

Warner Bros. Co.—6-page illustrated folder presents features of Spiratube flexible tubing with wide range of applications including ventilation and conveying. It is noncollapsible, retractable, portable, quick-connecting and can handle air under almost all conditions.

65. Die Casting Machine

Wickes Brothers—8-page illustrated bulletin No. W-400 covers specifications, capacities, general operating data and adjustment features of model No. 4 high speed automatic die casting machine capable of making 600 shots per hour. Unit is designed for use with lead, tin and zinc alloys and is operated through single control panel.

66. Voltage Regulators

Sorensen & Co.—16-page illustrated bulletin No. S-2-47 describes line of alternating current voltage regulators and Nobatrons for direct current, discusses principle of operation and outlines applications in industry, laboratories, sound equipment, communications and instruments. Specification data and index of models are included.

67. Electrical Connector

Industrial Power & Equipment Co.—2-page illustrated bulletin No. 201 describes R-C-E industrial rubber-clad solderless electrical connector. Unit provides mechanically strong, quickly connected or disconnected electrical connection for indoor or exposed-to-weather applications. Patented locking feature produces equivalent of permanent connection.

68. Oilless Bearings

Neveroil Bearing Co. — 20-page illustrated catalog No. 13 describes Neveroil oilless and self-lubricating bearings, bushings and machine parts made of Graphex graphited metal. Characteristics, features, dimensional tolerances, applications, recommendations for machining, standard sizes and other data are given.

69. Small Speed Reducers

Euclid Machine & Tool Co.—12-page illustrated bulletin is entitled "The Facts about Euclid Universal Fractional Horsepower Speed Reducers." Input shaft can be above or below wormwheel as desired. Unit can be assembled with output shaft at right, left or vertical or have double shaft extension. Maximum torque and horsepower capacity are features.

70. Clutches & Couplings

T. B. Wood's Sons Co.—4-page illustrated folder No. 290 describes model GT clutches and cut-off couplings designed for paper mill service. Specification data and method for calculation of power requirements for paper machines are given.

71. Torque Motors

B. A. Wesche Electric Co.—8-page illustrated bulletin entitled "Custom Built Torque Motors and Collector Rings" covers design, engineering and construction details of special type motors for specific applications. Collector rings with 5 to 200-ampere capacity in standard and custom-built styles are described also.

72. Limit Switches

Electrical Mfg. Div., National Acme Co.—12-page illustrated file folder type bulletin No. EM-47 describes line of standard Snap-Lock heavy duty limit switches together with optional mountings, levers and standard parts. Featuring separate enclosures for mechanical and electrical mechanisms, switches have wide range of control applications.

73. Control Valves

Sinclair-Collins Valve Co.—19-page illustrated technical bulletin describes line of direct and reverse acting control valves for use with steam, air, liquid and gas at pressures from 0 to 250 pounds per square inch. They are available with V-port, flat or bevel seats. Capacity charts and dimensional data are included.

74. Stainless Steel Wire Cloth

Buffalo Wire Works Co.—6-page illustrated folder form No. 596 describes features and uses of corrosion, abrasion and wear resisting stainless steel wire cloth in chemical, dairy, abrasive metal crushing, textile, paint, flour, food processing, pharmaceutical, photographic and metalworking industries. Table shows laboratory ratings on corrosion resistance.

75. Rubber Latices

B. F. Goodrich Chemical Co.—9-page technical service bulletin No. 47-H1 describes Hycar American rubber latices, which are stable suspensions of spherical particles of butadiene-acrylonitrile copolymers, for use particularly in paper and textile mills for saturation, impregnation and coating applications.

76. Metal Tubing Circuits

Parker Appliance Co.—76-page illustrated handbook No. 111 covers selection, sizing, layout and installation of metal tubing circuits. Basic data underlying specialized techniques required for design and rapid installation of long life, leakproof systems are presented for use by design, assembly and plant engineering personnel.

77. Air Control Valves

Logansport Machine Co.—48-page illustrated catalog No. 90 describes complete line of two, three and four-way air control valves for any type operation. Bleeder, pilot pressure and operating valves and control switches as well as other accessory equipment are described also. Typical circuit diagrams show suggested installation of air control valves.

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on developments in "New Parts" and "Engineering Department" sections—or if "Helpful Literature" is desired—circle corresponding numbers on either card below.

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78. Worm Gear Speed Reducers

Cleveland Worm & Gear Co.—8-page illustrated bulletin entitled "Proof of the Pudding" presents six case studies of savings made by installation of Speedaire worm gear speed reducers.

79. Welding To Specifications

Spotweld, Inc.—4-page illustrated bulletin No. 100 outlines advantages of specialized service, gas and arc welding facilities, metal forming, painting and spraying, production assembly and sample development design and consultation available to manufacturers.

80. Tools & Special Machinery

Zagar Tool, Inc.—28-page illustrated catalog No. MD-9 describes collets, fixtures, gearless multiple spindle drilling and tapping head, 20 and 36-inch horizontal broaching machines and broaches and adapters.

81. Tracing Cloth

Holliston Mills, Inc.—Two folders contain samples of Micro-Weave All American blue pencil tracing cloth and Pel-X water repellant white pencil tracing cloth. Complete price list is given for both types of cloth.

82. Hydraulic Cylinders

Electrol Inc.—4-page illustrated bulletin No. CVI-25-16 presents data on straight-line force, lightweight, precision made hydraulic cylinders in 17 sizes. Cross-sectional drawings of four types show design and construction.

83. Permanent Magnets

General Electric Co.—35-page illustrated booklet presents technical information and data on characteristics of G-E permanent magnets and covers their design, properties and applications.

84. Machine Handles & Cranks

Balcrank Inc.—4-page illustrated bulletin form No. 2172 describes line of balanced cranks, compound rests, machine handles, clamping levers and counter-balanced wheels for installation on all types of machines.

85. Aluminum Coatings

Watson-Standard Co.—Article entitled "How to Select Coatings for Aluminum" discusses specially compounded finishes for aluminum castings, extrusions, forgings, sheets and coils and considers both functional and decorative coatings. Peculiar properties of aluminum requiring special coatings are outlined.

86. Miniature Speed Changers

Metron Instrument Co.—Illustrated data sheet No. MPS-3C describes line of miniature speed changers designed for operation at speeds up to 20,000 revolutions per minute and for torques up to 2 inch-pounds. They are available in wide range of speed ratios and are applicable to controls and instruments and for experimental work, small power devices and model making.

87. Drier Rolls

Lukenweld, Inc.—8-page illustrated bulletin entitled "Steel Plate Drier Rolls that Speed Production" describes units for rapid drying and cooling of ink, pharmaceutical powders, plastics, paper, chemicals and other materials. Of all-welded construction, these rolls feature maximum strength, rapid heat-up, economical operation, elimination of warpage and long service life.

88. Pedestal Spot Welders

Progressive Welder Co.—Illustrated technical bulletin No. 503 presents data on line of Economy type standard spot welders adaptable for miscellaneous spot welding and for high production work. They are available in 30, 50 and 75 kilovolt-ampere sizes in three throat depths of 18, 24 and 30 inches. Different types of interchangeable electrode holders and electrodes can be furnished.

89. Precision Gears

Charles E. Crofoot Gear Corp.—4-page illustrated folder depicts plant production and wide range of typical precision gears manufactured to specifications. Gears made include small and medium sizes up to 12 inches in diameter and from 72 to 6 pitches.

90. Electronic Controller

Foxboro Co.—Illustrated bulletin No. 397 describes Dynalog electronic recording pyrometer which has sensitivity of 0.01 per cent of full scale range. Instruments with ranges from —200 to 2800 F. are available for use with thermocouples and electric resistance bulbs. Units can be used also for measurement and control of humidity, force, strain, pH, speed and other process variables.

91. Power Transmission Units

Fafnir Bearing Co.—8-page illustrated folder No. LAK contains information about light duty series of pillow blocks and flange and cylindrical cartridges equipped with sealed, wide inner ring ball bearings. They are suitable for carrying light or normal loads in applications where simplicity of installation is important factor. Specifications, sectional drawings and load ratings are included.

92. Shop Equipment

Standard Pressed Steel Co.—40-page illustrated catalog form No. 602 presents specifications and descriptive data on Hallowell chairs and stools, cabinets, dollies, drawers and drawer tier units, foreman's desks, locker room benches and bench legs, stock carts, tables, tool stands, workbench tops, tote boxes, welding tables, work benches and other types of shop equipment.

93. Crankshaft Type Magneto

Scintilla Magneto Div., Bendix Aviation Corp.—16-page illustrated booklet KM-No. 1 describes crankshaft type K-magneto for ignition on 1 and 2-cylinder industrial, automotive and marine engines. Similar to aviation type magnetos, it features reliability, simplicity, light weight, compact design and moisture-resistant characteristics.

94. Electric Fixture Wires

Radix Wire Co.—10-page illustrated catalog No. FW-1-200 describes line of Radibestos asbestos insulated flexible cords and fixture wires of single, double and triple-wire type. Tables of standard sizes, dimensions, weights and packages are given.

95. High Pressure Pumps

John Bean Mfg. Co.—4-page illustrated folder No. L-623 presents information on industrial high pressure pumps of plunger cup packing type designed to deliver volumes from 2 to 80 gallons per minute at pressures up to 800 pounds per square inch. Charted specifications and drawings explain operating efficiencies.

96. Gravity Conveyor

Rapids-Standard Co. — 24-page illustrated catalog No. C-142-4 presents information on line of Rapid Wheel and Rapid Roller gravity conveyors and accessories. All types are described and typical applications are shown. Belt conveyors, floor trucks, casters and hand trucks are described briefly also.

97. Thermoplastics

Tennessee Eastman Corp.—32-page revised book "Tenite", fifth edition, covers characteristics, manufacture, fabrication, applications and features of Tenite cellulose ester thermoplastics. Completely indexed, book is designed for engineers who can utilize material in design applications.

98. Metric Conversion Table

Babcock & Wilcox Tube Co.—8½ x 11-inch technical wall chart No. 112A is table giving millimeter equivalents of decimal inches. Also given are conversion equivalents for length and weight. Reverse side of chart gives list of company's products and location of sales offices.

99. Plastics Control Parts

Kurz-Kasch, Inc.—12-page illustrated catalog No. 103A gives dimension and specification data on molded plastics radio and instrument knobs and control balls. Special design and molding services, in addition to stock molds available, are discussed.

100. Plastics Cable Insulation

Bakelite Corp.—12-page booklet entitled "Kabelitems" No. 16 contains information on Vinylite plastics wire and cable insulating compounds. Eight series of plastics are covered with emphasis on properties of standard and made-to-order compounds. Tables of physical and electrical properties are given.

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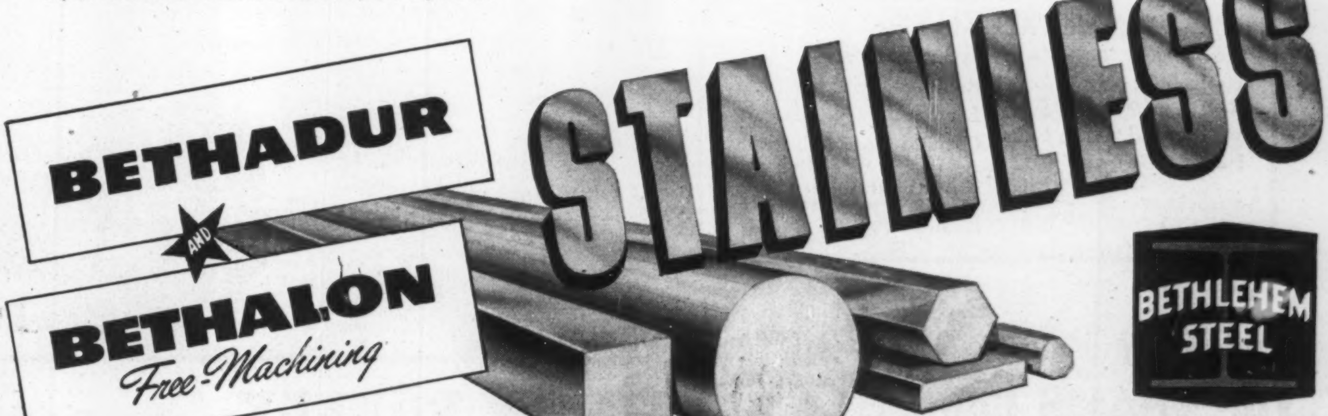
are you making any of these of stainless ?

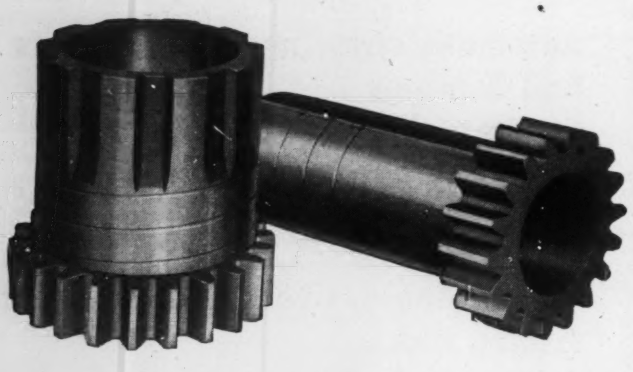
- Automatic screw machine products
- Ball bearings
- Candlesticks
- Cold- and hot-headed products
- Cutlery
- Fastenings
  - bolts, nuts, rivets, screws, studs
- Fishing tackle
- Forgings of all types
- Gauges
- Golf club heads
- Hardware
- High-temperature parts
- Marine fittings
- Measuring instruments
- Meat hooks
- Micrometers
- Nozzles
- Pump shafts
- Ratchets
- Retorts
- Seamless tubing
- Spark plug cores and shells
- Supports and brackets
- Surgical and dental instruments
- Table flatware
- Tie rods
- Turbine blades
- Valve parts

There's no doubt about the increasing demand for stainless steel parts. Your use of top-quality stainless bars can be assured by selection of the proper grade from the complete line of Bethalon (free-machining) and Bethadur stainless steels. Bethlehem metallurgists stand ready at all times to work with you in the planning and production of stainless steel products.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
On the Pacific Coast Bethlehem products are sold by
Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation



30 years of experience in producing stainless steels



Precision gears—
Custom Made
for Every Requirement

PRECISE operation of any product demands precision gears. By designing gears especially to meet the requirements of your product you can generally be assured of more efficient performance and can frequently simplify operation. Here at Adams, we are specialists in producing gears made exactly to your specifications. While your product is still on the drawing board, get in touch with Adams. We believe we can offer the solution to your gear problems. Write for complete details, today. THE ADAMS COMPANY, 1942 Tower Street, Dubuque, Iowa.

The ADAMS Line	
Spur Gears	Splined Shafts
Helical Gears	Racks
Bevel and Miter Gears	Lead and Feed Screws
Worms and Worm Gears	Ground Tooth Gears (spur and helical)
Internal Gears (spur and helical)	Shaved Tooth Gears (spur and helical)
Sprockets	
Ratchets	Ground Thread Worms

The ADAMS Company
Dubuque, Iowa, U. S. A.
ESTABLISHED 1883

GEARS

FINE GEARS MADE TO
YOUR SPECIFICATIONS

TOUREK BALL JOINTS . . .
the recognized standard!

Manufacturers throughout the nation look to Tourek to supply their requirements for ready-made ball joints in many different styles and sizes.

For over twenty-five years Tourek *famous* Ball Joints have led in design and performance . . . their acceptance by major industries everywhere has long established them as *the recognized standard!*

Tourek's broad experience, engineering ability and production facilities are at your disposal to design and manufacture all types of special ball joints to meet your particular applications. Write today for complete data about Tourek *famous* Ball Joints.

J. J. TOUREK MANUFACTURING COMPANY
4701 W. 16th Street, Chicago 50, Illinois

MAKERS OF PRECISION
SCREW MACHINE PRODUCTS

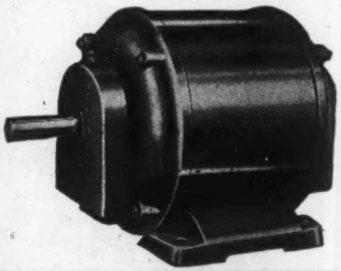
ESTABLISHED 1920
TOUREK
FAMOUS BALL JOINTS

Design Engineers Specify

VALLEY
Ball Bearing
MOTORS

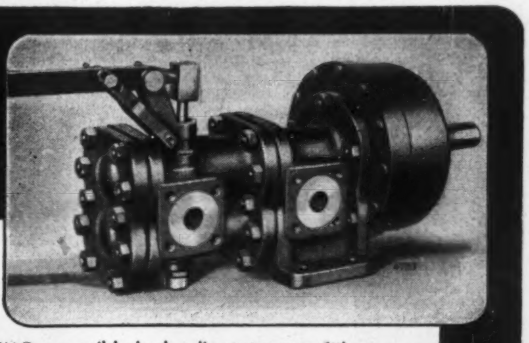
Because—

- They offer more flexibility in power planning.
- They are built to meet unusual power loads and high temperatures.
- They meet all operating conditions where hazards of liquids, chips, etc., dropping into the motor are involved; as well as splash conditions.
- Being made in ½ to 75 h. p. sizes, they offer wide adaptability.



Valley

VALLEY
ELECTRIC CORPORATION
4221 Forest Park Blvd. • St. Louis 8, Missouri



IMO reversible hydraulic motor permitting infinite speed variation in either direction

IMO POWER UNIT

The IMO principle embodied in a hydraulic motor makes an exceptionally simple, compact and reliable device for hydraulic power transmission.

IMO hydraulic motors can be furnished for operation at varying speeds in either direction with corresponding variation in output.

For information send for catalog 1-130-D

IMO means I MOVE OIL

IMO PUMP DIVISION of the
DE LAVAL STEAM TURBINE CO.
TRENTON 2, NEW JERSEY

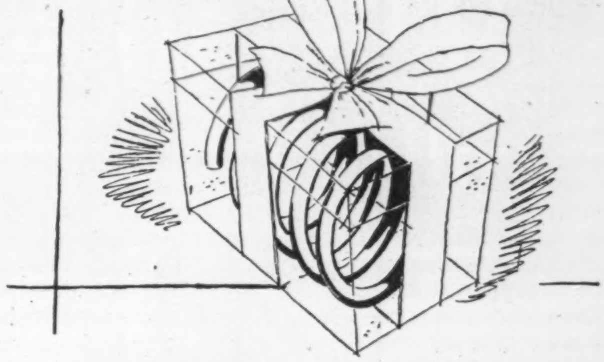
CAPS

Forged to fit . .

and stay on the job like no other type of processed metal can do. They're S.A.E. 1025 steel, used in gauge column manufacturing, forged *right* by Smith-Armstrong-right density for smooth machining, right analysis for toughness, right in every way for complete satisfaction.

Smith-Armstrong FORGE, INC.
1209 MARQUETTE ROAD CLEVELAND 14, OHIO

"Luxury" SPRINGS



DON'T CONTRIBUTE TO LOWER COSTS

It may be wise for you to analyze carefully the spring requirements of your products to make sure you are not wasting money through "Luxury" specifications. Possibly, through habit, you are using the same springs for one product that you use for another because they "operate successfully." Or your product's present design doesn't demand the same "fussy" springs the old design called for. You may be using ground end springs, for example, when they are unnecessary, or you may specify tolerances to plus or minus 2 or 3% when even a 10% tolerance would be sufficient for the job to be done.

Unnecessary specifications add to the cost of springs—and to the unit cost of products. Many times, product design can be altered ever so slightly to take advantage of a more economical and equivalent spring.

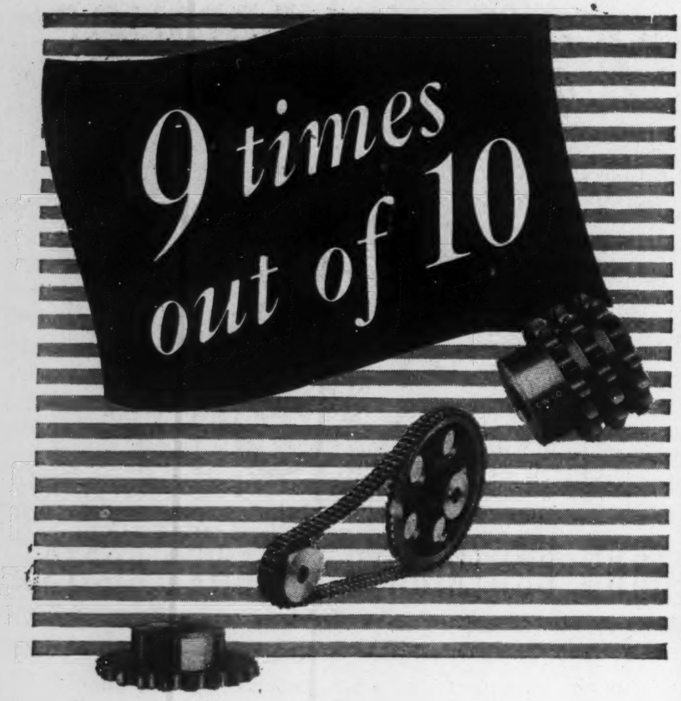
All these things are quickly recognized by Lewis Spring engineers. They are experienced in all phases of spring design, production and applicability to products. Lewis has saved manufacturers thousands of dollars by recommending and supplying the most practical and economical springs for the job.

There is a Lewis representative near you ready to help solve your spring or wireform problems. We shall be glad to send him to see you, with no obligation, of course. Wire or write us.

LEWIS SPRING & MFG. CO.
2652 NORTH AVENUE, CHICAGO 47

Lewis PRECISION SPRINGS

THE FINEST LIGHT SPRINGS AND WIREFORMS OF EVERY TYPE AND MATERIAL



CULLMAN

Stock Design SPROCKETS

will do the job—Better!

With 2,000 types to select from—you are almost certain to find just the size you need for practically every transmission requirement—ready for immediate delivery. Cullman Sprockets—produced by fast, low-cost, high-precision methods—asssure top operating efficiency. "Specials," too, *are quickly available*—made up by exclusive Cullman methods and specialized equipment.

CULLMAN
SPROCKETS

Write today for free catalog containing useful data and helpful facts for sprocket users. It lists dimensions.

CULLMAN WHEEL COMPANY
1336 Altgeld Street
Chicago 14, Illinois

for
SERVICE
on
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VIKING
ROTARY
PUMP
Call
Your
Nearest
VIKING
Repre-
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The Viking Pump Company is represented by a nation-wide sales and service organization in key cities from coast to coast . . . from Canada to the Gulf. Is your pumping installation operating at high efficiency? Do you have a pump maintenance problem? Write or call the Viking representative nearest your plant for service.

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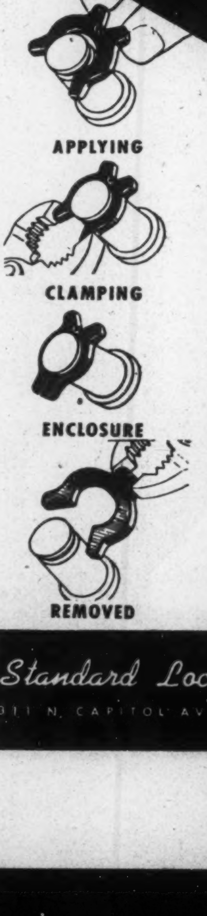
See Our Catalog In SWEETS
Viking PUMP COMPANY
Cedar Falls, Iowa

STANDARD X WASHERS



1. Efficient and economical
2. Quick, positive assembly
3. 360 degree closure, which supports greater thrust load
4. Quick, easy removal, which simplifies service or repair

Standard X washers are available for the following pin diameters: 7/32" to 17/32".

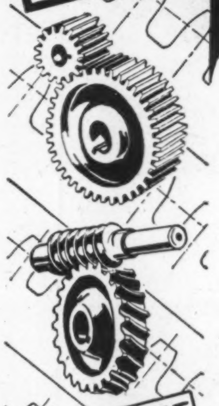
Write for Bulletin 26 containing complete specifications.

Standard Locknut & Lockwasher, Inc.
311 N. CAPITOL AVENUE • INDIANAPOLIS 4 INDIANA

For GEARS

Exactly to your specifications use GEAR SPECIALISTS!

Abart



Abart's long gear engineering experience, with most modern equipment, is concentrated on gears to each customer's individual requirements. Abart Gears therefore are not just another standard item. This accounts for the Abart superiorities in gear performance, long life and economy.

Bring your gear problems to Abart: Spur, Bevel, Worm, Worm Wheels, Helical and Spiral, Internal, Sprockets and Machine Racks. Any quantity, small or large. Send sample, B/P or specifications for prompt estimate.

ALSO ABART SPEED REDUCERS. WRITE FOR CATALOG!

Abart GEAR & MACHINE CO.

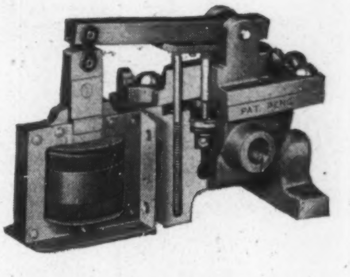
4821 W. 16TH ST. CHICAGO 50, ILL.

CRESCENT AIR VALVES

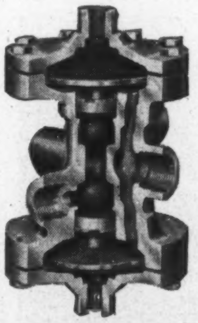
MODEL 24S

Four-Way, Lever Actuated, Solenoid Controlled . . . .

Stainless steel ball Valves. Bronze body and seats . . . Made in ¼" size only, but may be used in place of many conventional ⅜" valves due to large volume output. Available for manual control.



Crescent Air Valves are sturdy, compact, fast-acting. Designed for the continuous operation of single and double acting air cylinders. Abnormally large volume output. May be operated at any speed of practical value. Both models shown have completed over 20 million cycles without leaks or repairs. Tested for pressures to 140 psi.



MODEL 12

Four-Way, Diaphragm Actuated, Pilot Controlled . . . .

Tough, oil-resistant rubber diaphragms and ball valves. Bronze body and seats. Made in ½" size only, but with large volume . . . Couples directly into pipe line connecting cylinder ends.

CRESCENT VALVE COMPANY

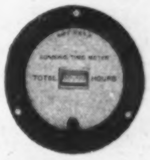
6073 State St., Huntington Park F-1, Calif.

WHEN PRODUCT PERFORMANCE DEPENDS, ON TIME AS A FACTOR OF CONTROL

. . . YOU CAN RELY ON

Cramer

DESIGN
QUALITY
ACCURACY



RUNNING TIME METERS

Synchronous motor driven. Register automatically and cumulatively total operating or idle time on circuits, machines, systems.

TIME DELAY RELAYS

Provide adjustable or fixed time delay between operation of a control circuit and subsequent opening or closing of a load circuit.

SYNCHRONOUS MOTORS

Permanent magnet type for applications requiring a constant speed at a given frequency. Small size. 30" ounce torque. Twenty-eight speeds from 60 rpm to 1/24 rph.

For a wide range of standard timers, controls or special adaptations for specific applications, consult R. W. CRAMER CO., Box No. 6, Centerbrook, Conn.

Cramer SPECIALISTS IN TIME AS A FACTOR OF CONTROL

INTERVAL : DELAY : CYCLE : IMPULSE : PERCENTAGE

ALLEN

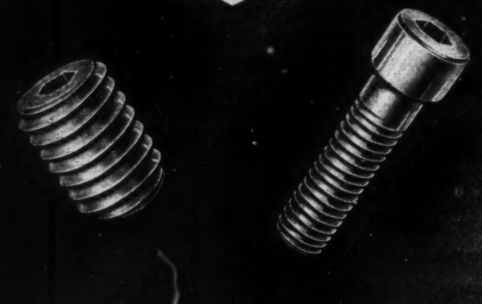
ANNOUNCES

STAINLESS STEEL

HEX-SOCKET SCREWS

NOW CARRIED IN STOCK

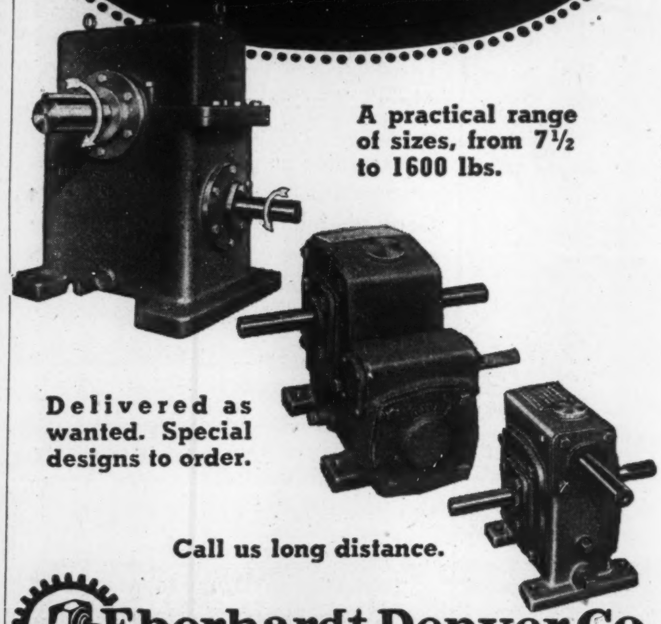
A NEW ADDITION TO THE ALLEN HEAD LINE



NON-CORRODING "ALLENS" for applications where steel is subject to excessive moisture, chemical fumes or corrosive vapors. Made of "18-8 Type" *Stainless,* non-heat treated, non-magnetic. Set screws: stock sizes #6 to ½" diameter; cap screws: #8 to ½". N. C. threads only. Class 3 fit; Allen precision fastenings... Order of your local Allen Distributor, or write us for samples and literature.

THE ALLEN MFG. COMPANY
HARTFORD 2, . . . CONNECTICUT, U. S. A.

SPEED REDUCERS *from stock*



A practical range of sizes, from 7½ to 1600 lbs.

Delivered as wanted. Special designs to order.

Call us long distance.

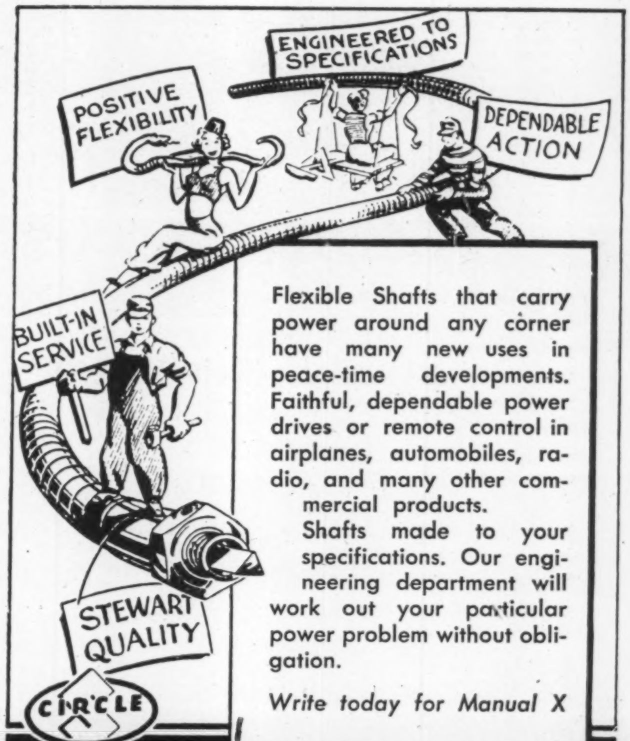
Eberhardt-Denver Co.
GEARS AND SPEED REDUCERS
1416 West Colfax Ave., Denver 4, Colorado Phone TAbor 7134

EWC WHEELS

Engineered for YOUR Product

There is a wide variety of EWC wheels and axles for every type of mobile equipment . . . one or several may be ideally suited to your product. For unusual wheel problems, we offer you a complete engineering service, with a thoroughly experienced staff and unexcelled facilities. Write today for complete information.

ELECTRIC WHEEL CO., Quincy, Illinois, Est. 1890



Flexible Shafts that carry power around any corner have many new uses in peace-time developments. Faithful, dependable power drives or remote control in airplanes, automobiles, radio, and many other commercial products.

Shafts made to your specifications. Our engineering department will work out your particular power problem without obligation.

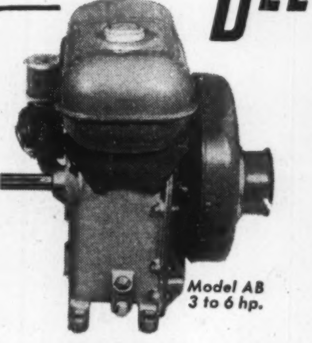
Write today for Manual X

F. W. STEWART MFG. CORPORATION

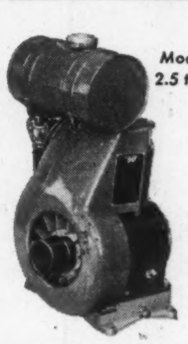
4311-13 RAVENSWOOD AVE. CHICAGO 13, ILL.

WEST COAST BRANCH: 431 Venice Blvd., Los Angeles 15, Cal.

BEE-LINE ENGINES



Model AB
3 to 6 hp.



Model BB
2.5 to 4.3 hp.

In Volume Production

Prompt Delivery

These 4-cycle, air-cooled gasoline engines are thoroughly service-proved in many applications. Light weight, compact design, and wide power range mean ready adaptability to many types of equipment and powering problems. Backed by 28 years of engine building experience, including manufacture of the famous Kinner aircraft engines.

Gladden Products
CORP.

635 W. COLORADO BLVD. ★ GLENDALE 4, CALIFORNIA

TEMPUS FUGIT... We wanted an arresting illustration for this advertisement, but we could not conceive a satisfactory method of portraying the idea of succeeding generations of industrious, God-fearing, peace-loving, free American workmen, applying their skills day after day, year after year, to make small and large ball bearings of steadily improving quality and accuracy.

Good copy is short, the experts tell us—then how could we talk about the wars, shortages, boom-times, depressions, stoppages during these fifty years, that sometimes hindered but never arrested the forward progress of a fine product.

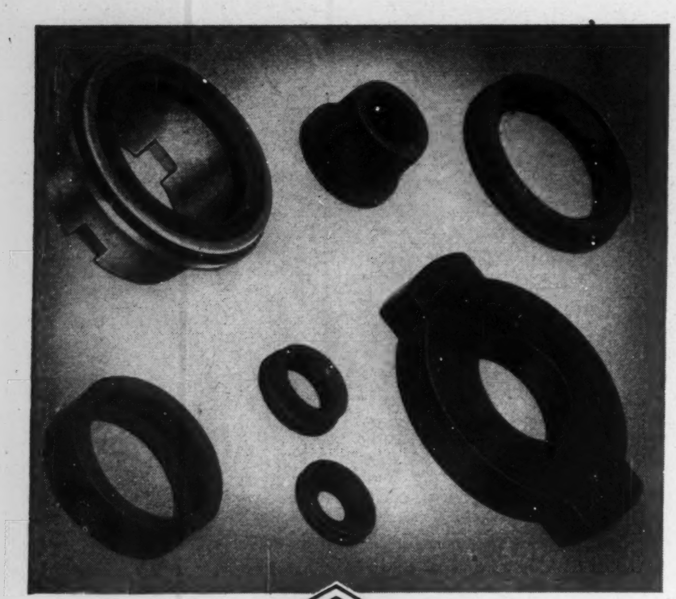
Or the challenge of invention—new automotive vehicles, industrial machinery, marine, farm and aviation equipment, to tax the ingenuity of our designers and engineers.

Or the loyal friends we serve in these various industries who have learned to know us and who hold BCA Ball Bearings in high regard.

So we pause to mark the passage of time, survey our accomplishments, and salute our patrons with a promise to continue to work for and with them in designing and planning for the future.

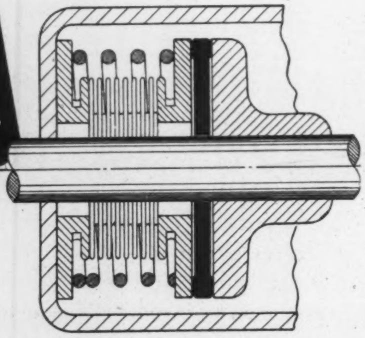
BEARINGS COMPANY OF AMERICA
LANCASTER, PA.

BCA RADIAL-ANGULAR CONTACT-THRUST **BALL BEARINGS**



PURE

CARBON SEAL RINGS CAN LICK *Your* Sealing Problems



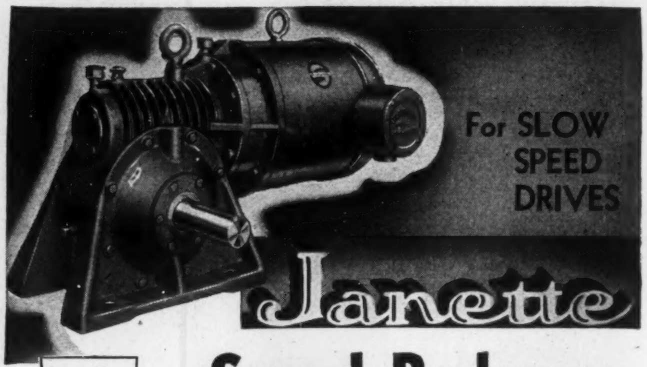
Pure Carbon Seal Rings are vital to solving sealing problems. Wherever two surfaces lap together lubrication is difficult and often impossible. Under these conditions the self-lubricating, non-seizing characteristics of carbon is extremely useful.

Chemically inert with a low coefficient of expansion, these rings are highly resistant to oxidation and corrosion. Pure Carbon materials are supplied in more than 20 different grades. Each grade is made from specially developed carbon to meet one or more of the varying requirements of temperature, speed, porosity and character of material to be sealed.

Our Bulletin No. 461 describes these grades in detail, giving specific recommendations for all types of service. Write for it today.

PURE CARBON CO., INC.

446 HALL AVENUE, ST. MARYS, PA.



For SLOW SPEED DRIVES

Janette

Speed Reducers

JANETTE is one of the few Speed Reducer Manufacturers who build their own Gears, Gear Boxes and Motors especially designed for use with Speed Reducers.

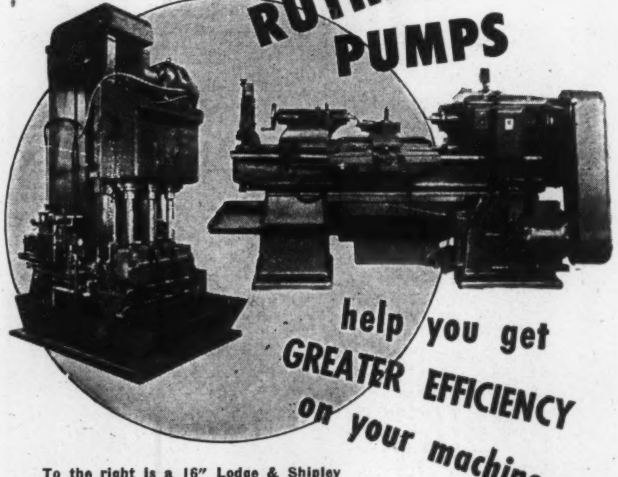
During the 37 years Janette Geared Electrical Machinery has been manufactured, skimping has never been permitted in any of their products. This policy has resulted in establishing for Janette a world wide reputation as a manufacturer of the highest quality electrical machinery.

Where DEPENDABILITY is a MUST, you can safely specify Janette Speed Reducers.

1/30 to 7 1/2 H.P.
.08 to 447 R.P.M.

Janette Manufacturing Company
556 W. Monroe St. Chicago 6, Ill.

RUTHMAN PUMPS



help you get GREATER EFFICIENCY on your machines

To the right is a 16" Lodge & Shipley Selective Head Engine Lathe equipped with a Model 2-P3 Long, 1/10 HP Gusher Coolant Pump.

To the left is a Baush Three-Spindle Vertical Boring Machine equipped with a Model 11025 Ruthman Gusher Coolant Pump.

Oversized pre-lubricated bearings requiring no further lubrication, electronically balanced, one-piece rigid shaft, no metal-to-metal contact gives greater efficiency in Ruthman Gusher Coolant Pumps. You are sure of years of trouble-free service at low maintenance cost when you specify Ruthman Gusher Coolant Pumps on your metal-cutting machinery.

Write for Catalog 10-C

THE RUTHMAN MACHINERY CO.
1811 Reading Road Cincinnati 2, Ohio

A COMPLETE SERVICE

CUSTOM MOLDED PLASTICS

INJECTION • EXTRUSION

• designing • engineering
• mold-making • all finishing
and assembly operations

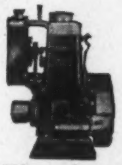
SEND US YOUR PRINTS
or
Call MElrose 6500

PEI

PLASTIC ENGINEERING, INC.
8506 LAKE AVENUE
CLEVELAND • 2 • OHIO

Couple Correct Design of Your Machine With Right Powering

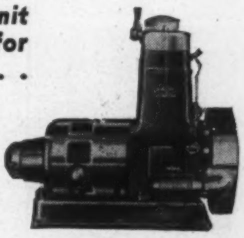
WITTE DIESEL ENGINES and DIESELECTRIC PLANTS



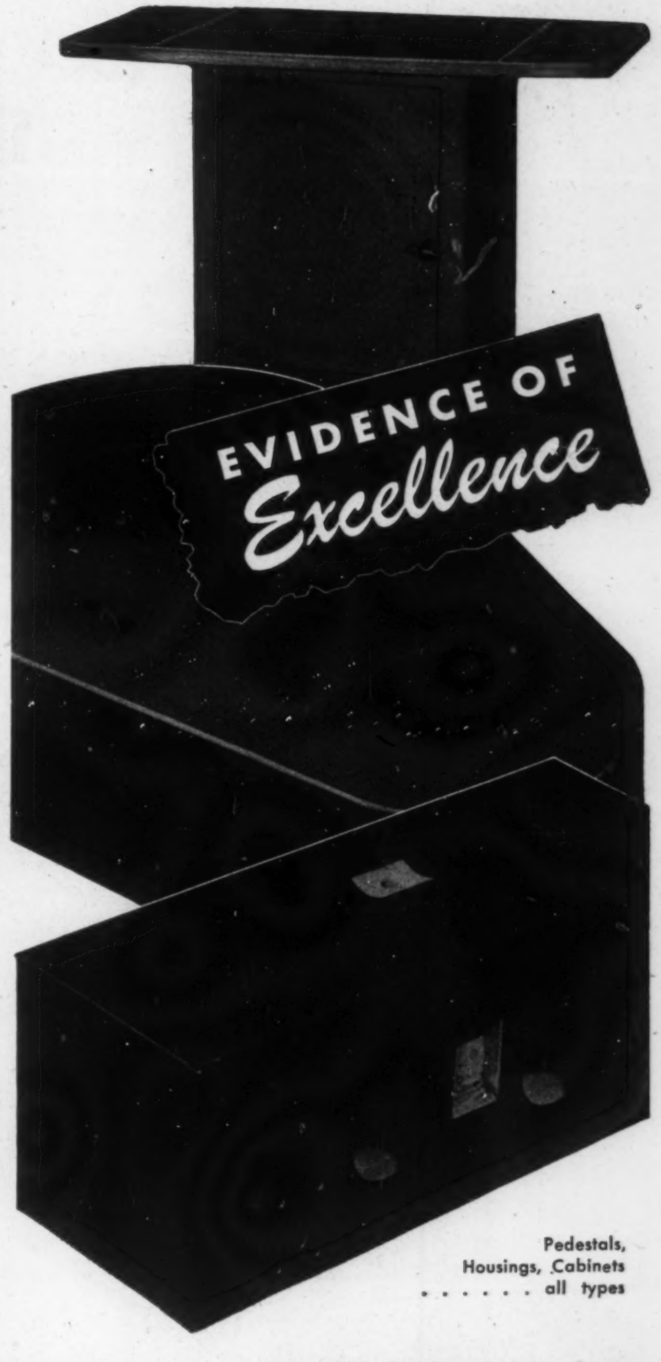
The most exhaustive tests you give a WITTE full-Diesel power unit installed in your machine will prove your machine can do its best continuously with WITTE power. *Full* Diesels, WITTE power units start and operate on low-cost Diesel fuel oil; occupy little space; need little attention. Produce no poisonous exhaust gases, so are safe for operation even in confined places.

There's a Full-Diesel WITTE Unit Ideal in Size, Type and Cost for YOUR Industrial Machine . . .

Vertical and horizontal models: WITTE Diesel Engines range from 4 to 12 H.P.; WITTE Dieselectric Plants from 3 to 10 KVA-AC; 2.5 to 8 KW-DC. Radiator, marine pump or tank cooking systems. For marine applications, heat exchanger cooling system is available equipped with two rubber impeller pumps permitting operation even with river silt and sand. Write for engineering recommendations and literature describing complete WITTE line.



WITTE ENGINE WORKS
DIVISION OF OIL WELL SUPPLY COMPANY — USS — UNITED STATES STEEL CORPORATION SUBSIDIARY
AMERICA'S PIONEER BUILDER OF SMALL DIESELS — KANSAS CITY 3, MO. U.S.A.



in sheet metal fabricating

It proves any case beyond a doubt. Demand it before you buy! And be sure it covers every detail of materials, workmanship and service—even to the temper of cooperation when you need the near-impossible. You'll be pleased with what you see at R & T. We welcome your inquiries.

R&T Co

MANUFACTURERS
Special Steel Equipment
Metal Cases—Cabinets
CONTRACTORS
Sheet Metal
Building Products
VENTILATION,
AIR CONDITIONING

THE
RIESTER & THESMACHER COMPANY
1526 W. 25TH ST. CHerry 0154
CLEVELAND, OHIO

Power... IN ANY DIRECTION WITH ELLIOTT FLEXIBLE SHAFTING

THE NEW
IMPROVED
ELLIOTT
FLEXIBLE
SHAFT
MACHINE

Let Elliott Design and Engineering technique, which developed this improved Flexible Shaft Machine, work with you on any Flexible Shaft problem you have to perfect the best Flexible Shaft for your products. Tell us what you want so we can submit samples, together with recommendations and quotations.

We Major in Special Applications of Flexible Shafting for Power Drives and Remote Controls.

ESTABLISHED 1932

ELLIOTT MANUFACTURING COMPANY

217 PROSPECT AVENUE BINGHAMTON, N. Y.

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Wheel Builders Since 1888

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Easily and quickly installed in line of drive of OLD or NEW machines

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Hand wheel control
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Prolongs your equipment life.
Better products with time-saving.
LOW COST speed control.

With touch of finger almost infinite number of speeds are obtained. Changes speed while running. Sizes up to 7½ h.p. Ratios up to 10:1. Ruggedly built. Heavy Duty Ball Bearings.

Send for Lovejoy-IDEAL Catalog. Also shows Variable Speed Pulleys Drive Sheaves, Adjustable Motor Bases, Wide V-Belts. Write

Mfd. by LOVEJOY FLEXIBLE COUPLING CO.
MFRS. OF LOVEJOY L-R FLEXIBLE COUPLINGS

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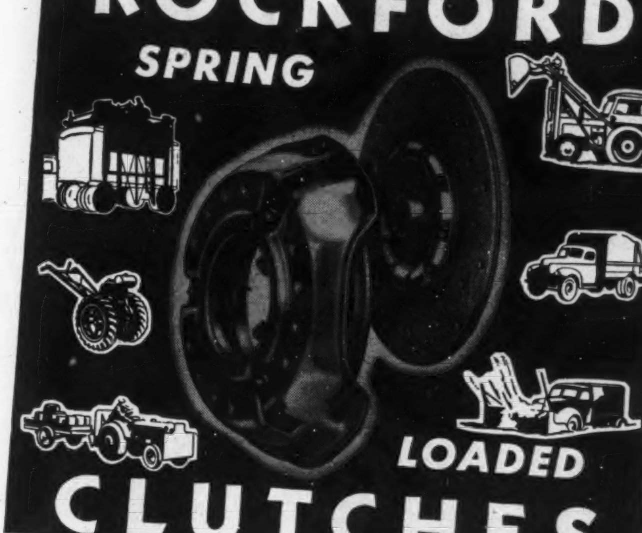
ROCKFORD SPRING LOADED CLUTCHES



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- CUSHIONED ENGAGEMENT
- VIBRATION DAMPENING
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- LIFETIME ADJUSTMENT

* The unique design of ROCKFORD Spring-Loaded CLUTCHES provides necessary spring load for the required torque — with light pedal pressure. This is accomplished by means of ample lever ratios and reduction of friction in operating parts. ROCKFORD Spring-Loaded CLUTCH advantages will benefit your products.

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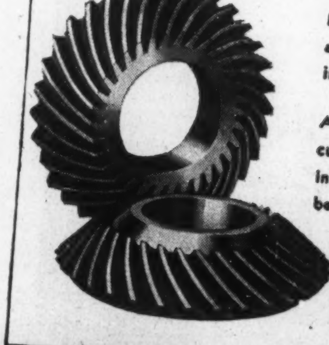

Maximum performance and dependability are two qualities that are absolutely essential in gears for any industrial purpose.

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For smooth, efficient operation at high speeds . . . specify Cincinnati Gears, *Good Gears Only!*

THE CINCINNATI GEAR COMPANY
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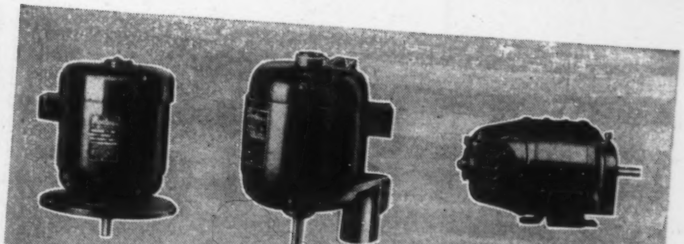

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You need not pick Peerless motors "off a shelf" for original equipment installations. More than 90% of all Peerless motors produced are manufactured to meet the specific operating requirements of the equipment with which they are to be used.

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THE PEERLESS ELECTRIC COMPANY
Manufacturers of Quality Motors for More than 50 Years
Single Phase—Polyphase—Direct Current
WARREN, OHIO

PUMPS

that

"NEVER LET YOU DOWN"

. . . for

- ★ *circulating liquids*
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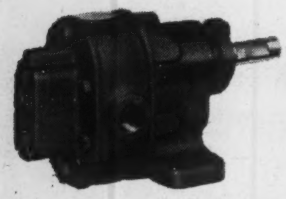
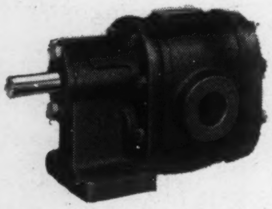
- ★ *supplying lubricant*
- ★ *supplying coolant*
- ★ *hydraulic installations*

The simple, sturdy construction and dependable, trouble-free operation of Brown & Sharpe Pumps are widely recognized throughout industry.
Brown & Sharpe Rotary Geared Pumps are made in several stock styles and sizes . . . capacities from ½ gallon per minute at 0 lbs. pressure to 37.6 gallons per minute at 0 lbs. pressure . . . for pressures up to 500 psi. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

We urge buying through the Distributor



Nos. 1S, 2S and 3S Rotary Geared Pumps with helical gears — for coolant, general circulation and low pressure hydraulic service. Renewable bearings. Mechanical Seals. With or without relief valves.



Nos. 53 and 55 Rotary Geared Pumps with roller bearings and helical gears; for hydraulic installations. Supply oil under pressure. Although designed for direct drive, can be pulley or gear driven.

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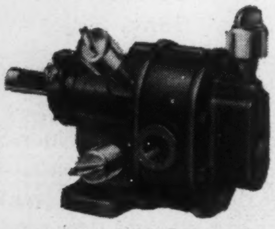

Nos. 21 and 23 Bronze Rotary Geared Pumps . . . suitable for providing circulation on water-jacketed engines and for pumping saline solutions.

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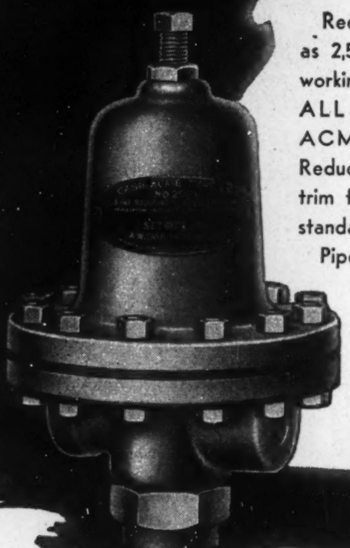

Reduce pressure as high as 2,500 pounds down to working pressures with an ALL BRONZE CASH ACME Type LS Pressure Reducing Valve. Nitralloy trim for longer service is standard.

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Getting steam or liquids into rotating machine parts used to mean a lot of trouble with stuffing boxes and steam fits. The Johnson Joint has changed all that. It's completely packless, self-oiling, self-adjusting and even self-aligning. Industry is finding new uses for it every day. Type B illustrated provides for condensate removal; other styles and sizes for all needs. Write for details.

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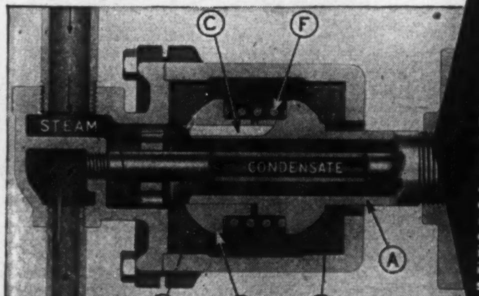

Nipple (A) connected to roll. Collar (B) is keyed (C) to nipple, but fits loosely so pressure can fill housing and force seal ring (D) in place. Both rings (D and E) are of carbon graphite, eliminate oiling and packing. Spring (F) is for initial seating only.

JOHNSON *Rotary Pressure* **JOINTS**

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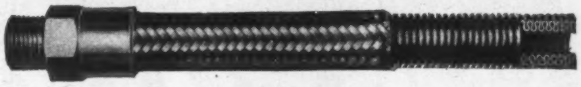

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EASY TO INSTALL

There is an Atlantic Metal Hose for virtually every type of service handling liquids, compressed air, gases, petroleum, steam and chemicals—where there is high temperature and vibration or where the hose is exposed to friction, abrasion, or rough handling. Interlocking types are also available in bronze and steel and various other metals in large sizes and long lengths.

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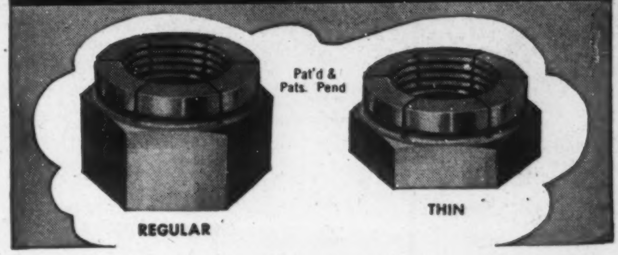

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Samples of our "Flexloc" Self-Locking Nuts will be sent free.

The one-piece, all-metal "Flexloc" packs maximum usefulness in minimum space by combining, as it does, a stop, a lock and a plain nut all in one.

Every thread — including the locking threads—takes its share of the load.

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Sizes from No. 6 to 2" in diameter — **millions in use!**

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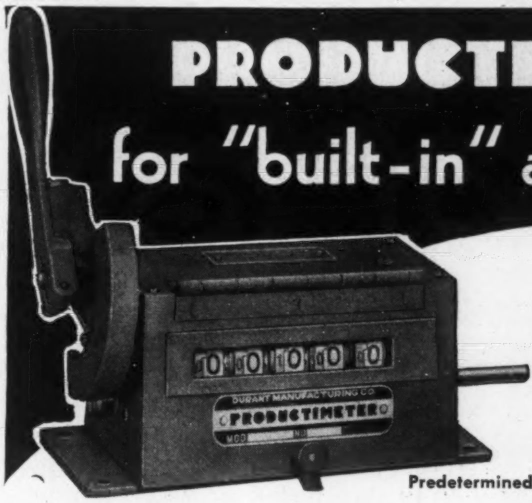
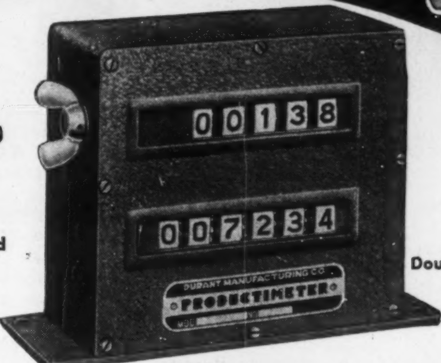
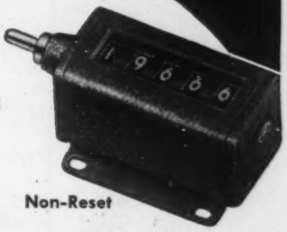


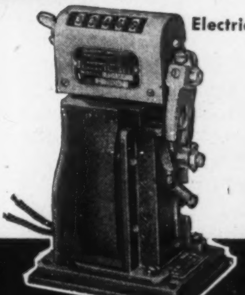
Predetermined



Double Deck

01670
PRODUCTIMETER
Rotary


Non-Reset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... Bear-Balancing Defeats Them!

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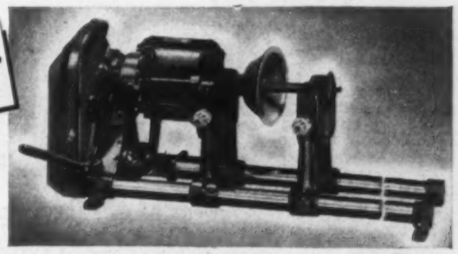
WRITE for NEW "340" BULLETIN!


Bear Balancer Model 340 handles most balancing work in this industry.

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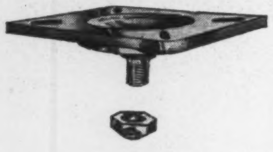
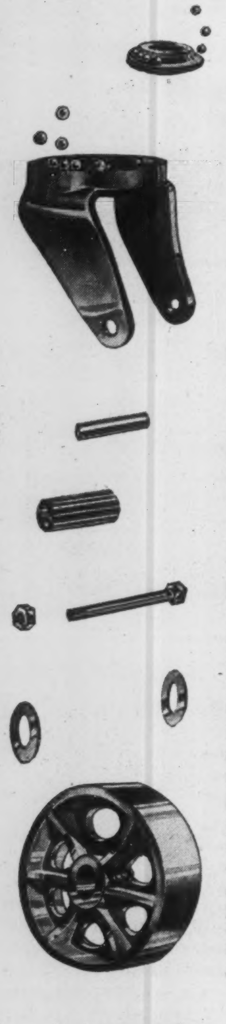
STATIC AND DY-NAMIC BALANCING MACHINES

This is why RAPIDS-STANDARD CASTERS are Better





Forged Top Plate and Yoke
Heavy drop forging of SAE steel. Fitted with drop forged thrust bearing. Entire assembly extra thick for greater capacity and shock resistance.

Flame-hardened Raceways
Double ball bearing accurately machined and flame-hardened, an exclusive Rapids-Standard feature which gives Rapids-Standard Casters greater capacity and provides longer wear without wobble.

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Highest quality hardened and ground balls assure smooth operation and longer life under heavy loads.

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Zerk fittings provided at all essential lubrication points. This positive lubrication method provides protection for smooth running bearings under all conditions.

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High carbon steel axle of ample size for carrying loads of recommended capacity. Hardened steel sleeve permanently locked to axle.

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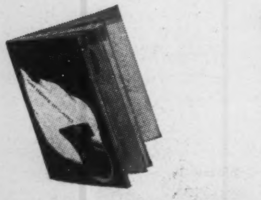

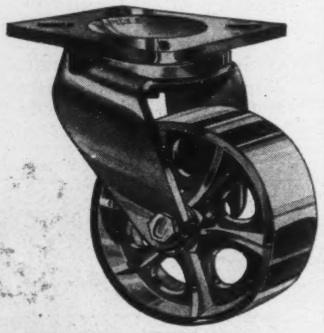

This new catalog lists the complete Rapids-Standard Caster line together with specification, capacities and suggestions for more efficient use. Write for your copy today.

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The Rapids-Standard Co., Inc.

Sales Div.—330 Peoples Nat'l Bank Bldg., Grand Rapids 2, Mich.

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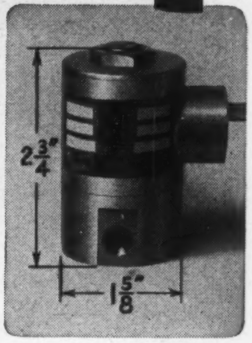
Stainless Steel Solenoid Valves



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Stainless steel parts highly resistant to corrosion and wear

Power consumption 10 watts max.

Pipe connections to specification

Also many special valves for handling pressures from 5 to 850 psi

For complete details and catalog write to

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The Skinner Chuck Co.
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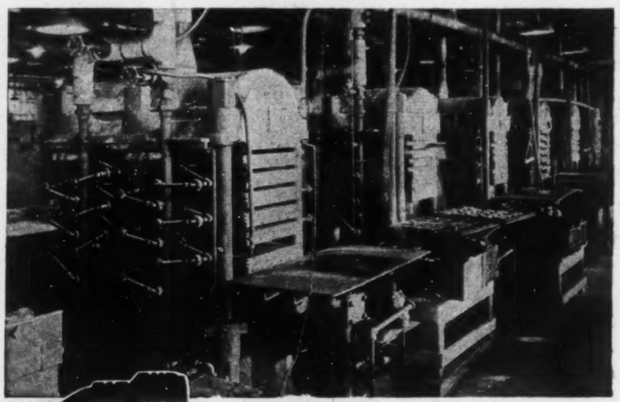

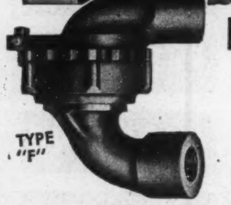

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FLEXO JOINTS

To convey steam, air, water, oil or other pressures to moving parts FLEXO JOINTS assure unrestricted flow in all positions. They offer the flexibility of hose with the strength of pipe. Of four simple parts—completely enclosed from grit and dirt—with no springs, no small or loose parts. Nothing to wear but the inexpensive inner seal. In four styles with sizes from ¼" to 3".

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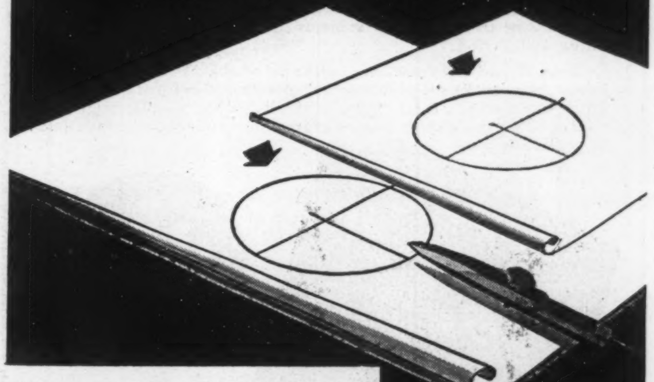

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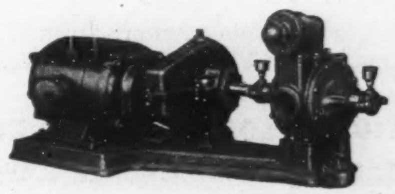
FACTS ROTARY PUMPS
BLACKMER

FACTS ABOUT ROTARY PUMPS

which explains why the "Bucket Design" (swinging vane principle) maintains pumping capacity by automatically compensating for wear and how the buckets, when finally worn out, are easily replaced and the pump restored to its normal capacity.



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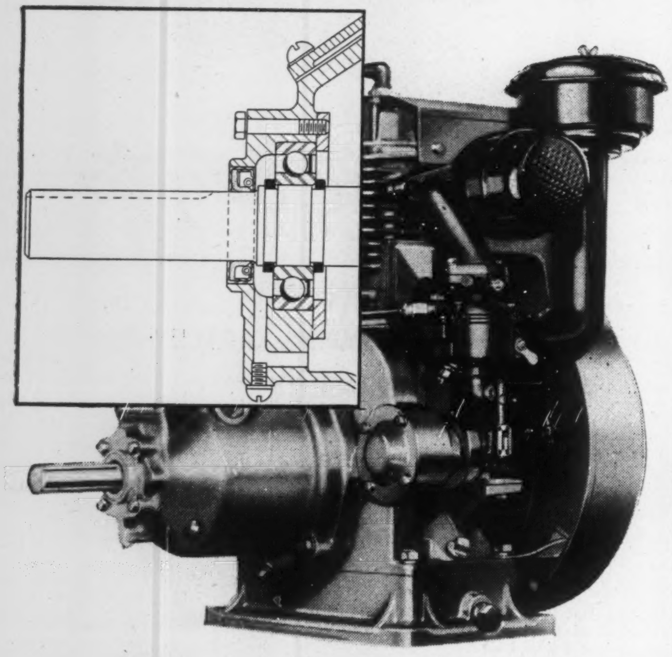

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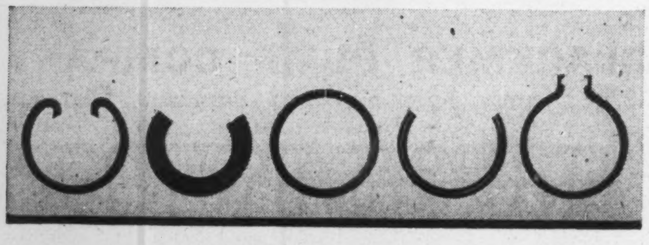

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Has Moved Into Its New Modern Building
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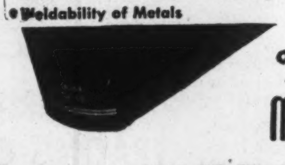

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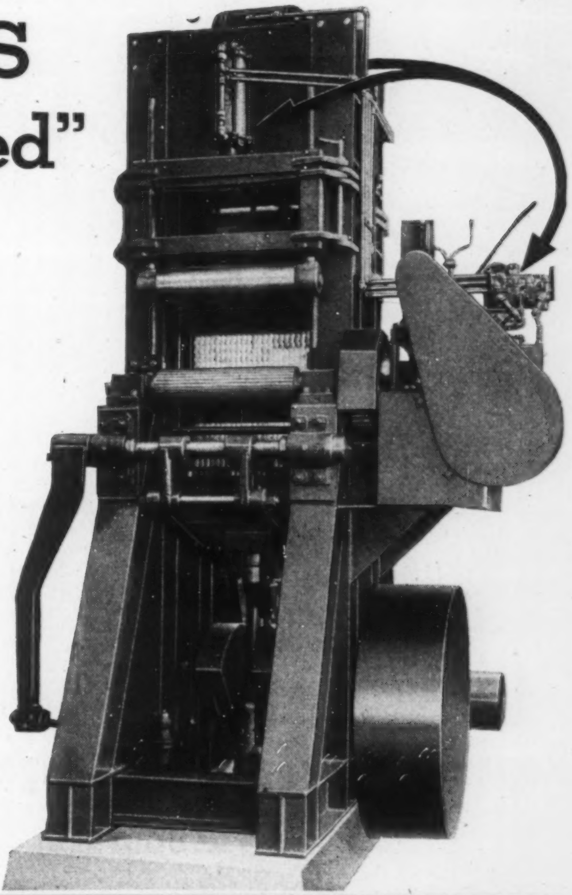

The Johnson Manufacturing Co., Seattle, Wash., builds Cant Gang Saws of this type in various sizes and capacities. The model shown employs two NOPAK Model "A" Air Cylinders (6" x 12") with Self-Regulating Cushions at both ends of the stroke. As the rolls are lowered by the action of the cylinders, they apply pressure on the *cant* (log) so that the feed-rolls engage the *cant* to feed lumber into the saw. Two ¾" NOPAK 4-Way Valves provide positive, accurate control of cylinder action at 100 p.s.i. air pressure.

This application indicates that NOPAK Valves and Cylinders are made for rugged, heavy duty service on machines which you may build for resale or use for production operations in your plant. Write for Illustrated Bulletin 92-A.

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NOPAK
VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE

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Ideal for
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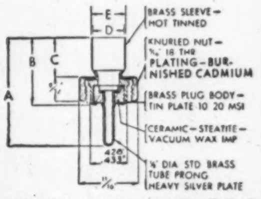
E
D
A
B
C
9/32"
BRASS SLEEVE—HOT TINNED
KNURLED NUT—9/16" 18 THR
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BRASS PLUG BODY—TIN PLATE 10 20 MSI
CERAMIC—STEATITE—VACUUM WAX IMP
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SUPPLIED IN 1 & 2 CONTACT TYPES

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SHIELDED TYPE
PLUGS & SOCKETS

LOW LOSS PLUGS AND SOCKETS FOR HIGH FREQUENCY CONNECTIONS

For quality construction thruout, and fine finish, see diagram above.

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For full details and engineering data ask for Jones Catalog No. 16.

JONES MEANS *PROVEN* QUALITY

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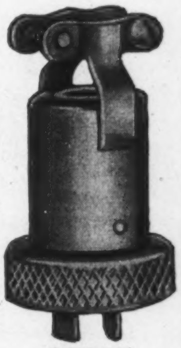

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S-202-B

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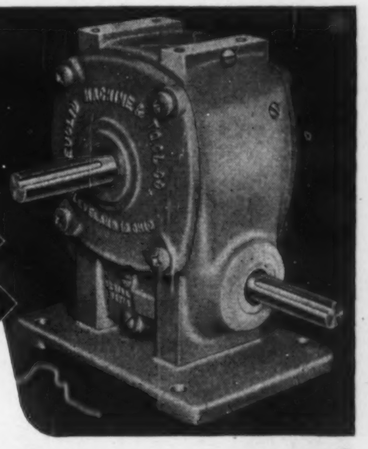
INCREASED TORQUE
MORE HORSEPOWER CAPACITY



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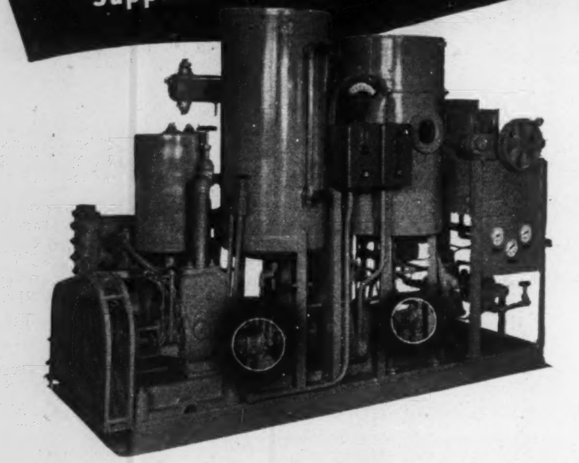
3-WAY UNIVERSAL SPEED REDUCERS

SUCTION

For Buckeye Oil-Purifying Process
Supplied by Roper Pumps

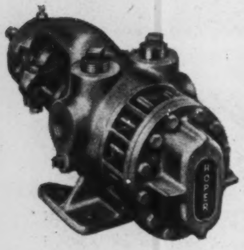


Roper Pump Meets Challenge of 28+" Vacuum

Buckeye Laboratories Corporation of Cleveland, Ohio, makers of equipment for cleaning, dehydrating, degasifying and stabilizing oil, install Roper Pumps as integral parts of their equipment. On the machine illustrated above, a Roper Pump transfers oil under pressure to the atomizing nozzles which in turn spray the oil mist into the vacuum chamber.

As the processing is completed another Roper pumps the purified oil from the vacuum chamber. This requires exceptional pumping efficiency to maintain a flow against the resistance of a 28+" vacuum.

Another example of Roper adaptability to an almost limitless range of uses.



Roper 4-port design offering 8 different piping connections cuts installation time and costs to a minimum... 4 piping arrangements with pump operating clockwise and 4 other arrangements for counterclockwise operation.

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Illustrating and describing pumps built to handle pressures up to 1000 lbs. p.s.i., capacities ¾ to 300 g.p.m. at speeds up to 1800 r.p.m.

ROPER
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GEO. D. ROPER CORPORATION

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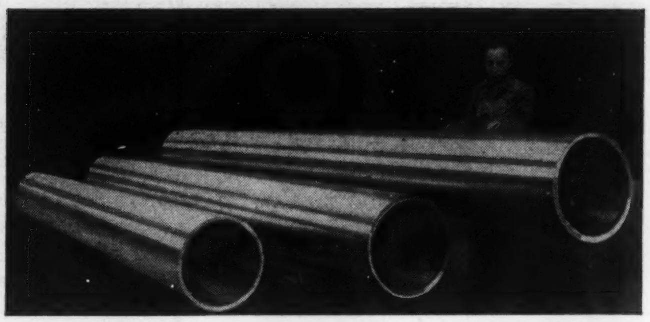

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SANDUSKY FOUNDRY AND MACHINE CO. SANDUSKY OHIO, U.S.A.

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Belt Fastener for A and B Belts of open end construction

Size No. A180 for A Belts
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Flex V fasteners are made in two sizes for joining A and B V-belts of special open-end cross-woven fabric construction and on drives rated as light duty with a belt speed of not over 3000 feet per minute. The fasteners must not be used on heavy duty or high speed drives or for joining or repairing V-belts that were originally endless.

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Folder No. V-12 gives complete details on this Flex V fastener with list prices, special tools and application information. Your request will bring a copy.

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Also sole manufacturers of Alligator Steel Belt Lacing for flat transmission belts. Alligator V-belt Fasteners for V-belts and Flexco HD Belt Fasteners and Rip Plates for fastening and repairing conveyor belts.

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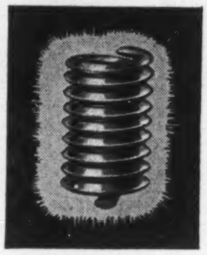

in 3 EASY STEPS with HELI-COIL Inserts*

MANY manufacturers are salvaging expensive parts by replacing stripped tapped threads with Heli-Coil Inserts. And they find that the salvage job provides an even *better tapped thread than the original.* It is done in 3 easy steps. (1) Drill out the old thread, (2) Re-tap, (3) Install Heli-Coil Insert.

Heli-Coil Inserts are precisely engineered helical coils of stainless steel or phosphor bronze wire, designed to fit threads of American National coarse and fine profiles, also ⅛—27 and ¼—18 A.N.P.T. sizes.

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Better Controls for Tomorrow's Designs

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Arens also manufactures a complete line of control accessories including heads, end fittings, mounting clamps and the Arens Dura-Grom.

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ARENS CONTROLS, INC.
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SAVE SPACE IN REAR ENGINE DRIVES — WITH

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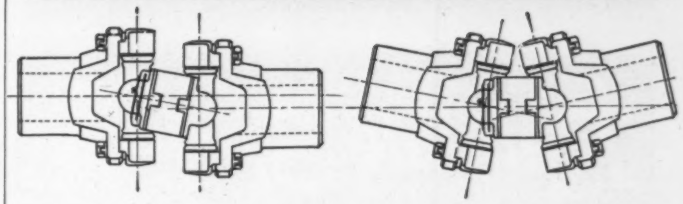
MECHANICS *Roller Bearing* UNIVERSAL JOINTS



MECHANICS close-coupled type Roller Bearing UNIVERSAL JOINTS are specially designed for operation within cramped quarters, and where shafts are out of alignment. These joints fit into spaces that engineers formerly considered too short for universal joints.

Unique features of MECHANICS Roller Bearing UNIVERSAL JOINTS make them unusually easy to install and service. The complete cross and bearing assembly can be removed simply by taking out the cap screws and separating the end yokes slightly. No flange is required for drive shaft connections. Accurately and durably built for long, heavy service, MECHANICS Roller Bearing UNIVERSAL JOINTS are inherently balanced for smooth operation.

Let our engineers show you how MECHANICS close-coupled Roller Bearing UNIVERSAL JOINTS conserve space and compensate for offset shafts, in your new and improved models.

Our new catalog — showing the complete line of MECHANICS Roller Bearing UNIVERSAL JOINTS — will be sent to manufacturers upon request.

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Roller Bearing
UNIVERSAL JOINTS

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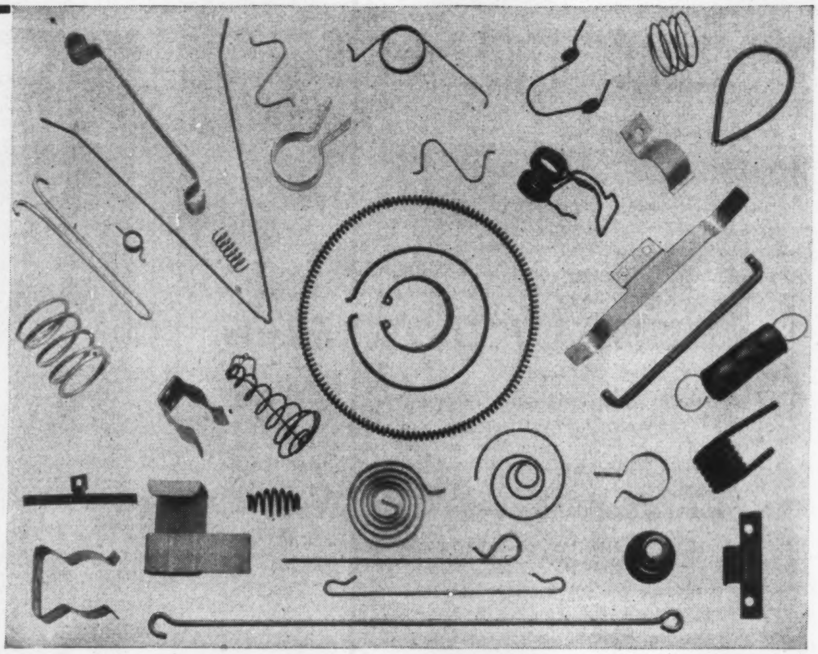

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ROUND AND FLAT WIRE SPRINGS · CLIPS · HOOKS · BENDS · LIGHT STAMPINGS

The Reliable Spring & Wire Forms Co.
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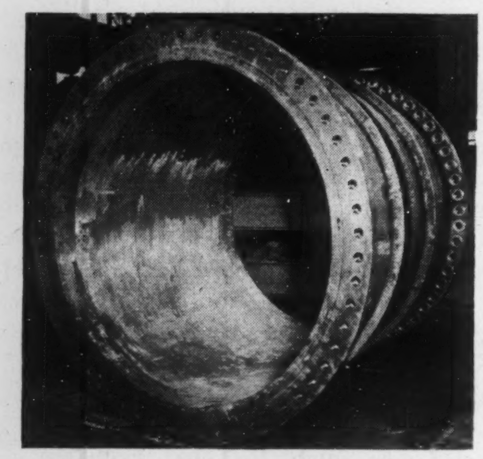
17,350 lb. BRONZE CASTING



. . . subjected to 125 p.s.i. hydrostatic pressure for 30 minutes

An unusual job for us? . . . No, for nearly 40 years we've made large intricate Bronze Castings for most every industrial and commercial purpose. . . . This particular casting was not only large, but accurate and pressure-tight as well. Made of our famous Hy-ten-sl Bronze, it had a Tensile strength of 90,000 p.s.i.; Yield point 45,000 p.s.i.; Elongation 18% in 2"; Brinell 200.

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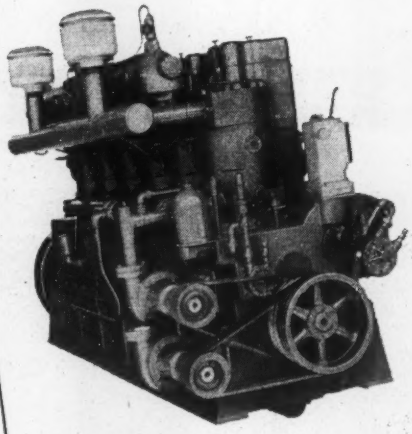

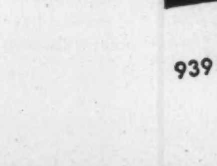

Save space, reduce costs and improve appearance with Tuthill Stripped Pumps built directly into the design of your machinery. Ideal for lubrication, coolant, hydraulic and liquid transfer service. Two types available: Type S, without mounting bracket; and Type SA, pumping elements only. Capacities up to 200 g.p.m. Write for Tuthill Stripped Pump bulletin.

TUTHILL PUMPS

TUTHILL PUMP COMPANY
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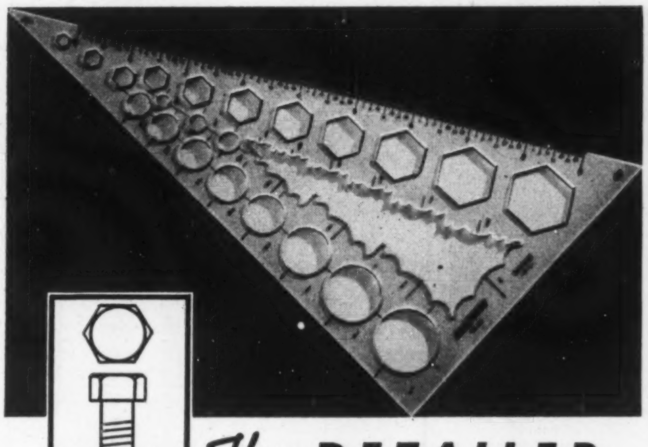

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Now furnished in stainless steel bulb and nut, an accurate, compact, durable instrument for the indication of liquid or gas temperatures. They are available in a variety of temperature ranges—from minus 40° F. to plus 500° F. Actuation is positive, direct with full freedom—no gears or pinions. Available in sizes 2", 2½", 3½" and 4½".

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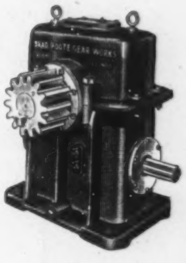
AVAILABLE
TO BE MADE UP FOR
PROMPT DELIVERY
(SOME RATIOS IN STOCK)

WORM GEAR AND GYRO SPEED REDUCERS

Worm Gear Speed Reducers

SIZE	QUANTITY	RATIO	INPUT H.P. 1750 RPM	RATING AT 1150 RPM
3RT	73	5 1/6 to 1	3.3	2.6
	143	10 to 1	2.5	2.
	15	15 to 1	1.85	1.5
	51	20 to 1	1.4	1.1
	9	25 to 1	1.0	.9
	74	30 to 1	.97	.78
	150	40 to 1	.74	.60
	73	50 to 1	.63	.50
	50	60 to 1	.50	.39
3-3/4 HT	5	5 2/5 to 1	5.7	4.7
	3	7 to 1	4.8	3.9
	16	10 to 1	4.4	3.3
	26	14 1/2 to 1	3.2	2.5
	9	20 to 1	2.4	1.9
	43	30 to 1	1.7	1.34
	24	40 to 1	1.22	1.00
	25	50 to 1	1.05	.84
	90	60 to 1	.85	.68
4RT or HA	3	5.8 to 1	6.5	5.3
	10	10 to 1	4.56	3.72
	13	16 1/2 to 1	3.2	2.63
	25	20 to 1	2.66	2.18
	50	30 to 1	1.93	1.56
	2	40 to 1	1.47	1.21
	29	45 to 1	1.31	1.08
	48	60 to 1	.99	.81



CATALOG 114

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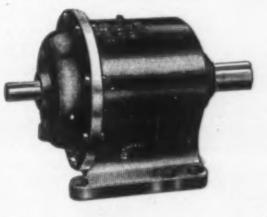
Write for prices and delivery dates



CATALOG 112

GYRO SPEED REDUCERS

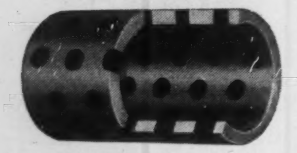
SIZE	QUAN.	RATIO	INPUT H.P. 1750 RPM	RATING AT 1150 RPM
G-7½	16	24 to 1	.87	.68
	9	30 to 1	.65	.50
	13	40 to 1	.48	.38
	8	50 to 1	.39	.30
	4	56 to 1	.35	.27
	10	60 to 1	.33	.25
	4	80 to 1	.26	.20
	4	100 to 1	.20	.16
	5	120 to 1	1/6	1/6
	3	200 to 1	1/6	1/6
	2	408 to 1	1/6	1/6
	4	480 to 1	1/6	1/6
G-15	7	30 to 1	1.3	.96
	9	40 to 1	.96	.74
	4	50 to 1	.77	.58
	35	60 to 1	.65	.47
	3	81-3/5 to 1	.50	.36
	55	120 to 1	.33	.25
	1	140 to 1	1/4	1/4
	1	360 to 1	1/4	1/4
G-25	8	40 to 1	1.5	1.
	9	50 to 1	1.25	.94

SIZE	QUAN.	RATIO	INPUT H.P. 1750 RPM	RATING AT 1150 RPM
	39	60 to 1	1.04	.79
	1	66 to 1	.96	.70
	8	80 to 1	.80	.60
	9	100 to 1	.64	.44
	10	116 to 1	.55	.40
	28	118 to 1	.55	.40
	1	142 to 1	.40	.30
	10	200 to 1	.32	.25
	6	235 to 1	1/4	1/4
	1	247 to 1	1/4	1/4
	9	360 to 1	1/4	1/4
	7	480 to 1	1/4	1/4
	2	2080 to 1	1/4	1/4
G-40	2	26 to 1	4.2	3.00
	5	25 to 1	4.2	3.00
	4	30 to 1	3.8	2.8
	7	40 to 1	2.83	2.13
	6	50 to 1	2.27	1.74
	4	60 to 1	1.90	1.46
	3	101 to 1	1.1	.89
	4	120 to 1	.98	.75
	4	180 to 1	.66	.50
	1	240 to 1	.50	.38
	4	400 to 1	1/4	1/4
	3	480 to 1	1/4	1/4
	3	610 to 1	1/4	1/4
	4	1200 to 1	1/4	1/4

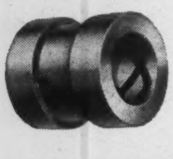
BRAD-FOOTE GEAR WORKS
1309 SO. CICERO AVE. CICERO, ILL. DEPT. A

Smoother performance . . . 3 to 4 times longer

RANDALL
graphited-bronze
BEARINGS


Drilled holes provide graphite lubrication

Above and below—bearings undercut for oil reservoir housing



Stop worrying about bearing failures. Specify *graphited-bronze* Randall . . . the only precision-machined bearing with lubricating graphite inserted right into the phosphor bronze sleeve.

The graphite alone provides lubrication that keeps equipment running smoothly for a long time. With an oil reservoir housing, wear is even further reduced by the oil-graphite film that's always between shaft and bearing.

Don't take chances. Always specify Randalls . . . the *graphited-bronze*, self-lubricating bearings you can depend on.

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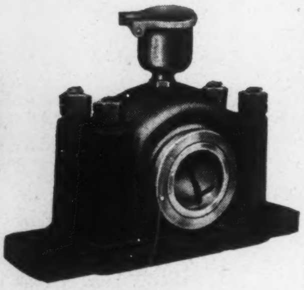
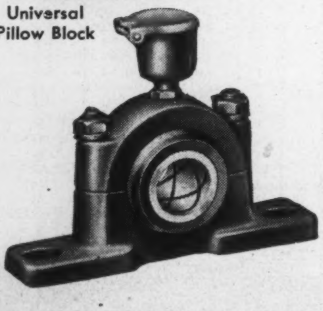
Every Randall Pillow Block has a self-lubricating *graphited-bronze* bearing centered in a rugged, self-aligning ball housing, with single or double oil reservoir.

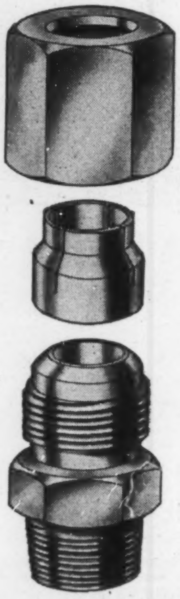
See Randall's complete line, get the details of exclusive *graphited-bronze* design and valuable installation hints. Write for Bearing Catalog GB-43 or Pillow Block Catalog 47.


Universal Pillow Block


Standard Pillow Block

Randall Graphite Bearings, Inc.
609 West Lake Street, Dept. 1217, Chicago 6, Illinois

NEW FLODAR Griptube FITTINGS



FEATURE

1. An alloy steel spring sleeve that protects the tube against breakage at the flare and supports the tube for the life of the installation.
2. The sealing of higher fluid pressures.
3. The absorption of excessive vibration.
4. The prevention of the sleeve from jamming within the nut.
5. A provision for self-alignment of tubes.
6. The reduction of installation, maintenance and replacement costs.

For all fitting and hydraulic leakage problems write for engineering drawings, specifications and illustrated folder.

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331 FRANKFORT AVE. CLEVELAND, OHIO

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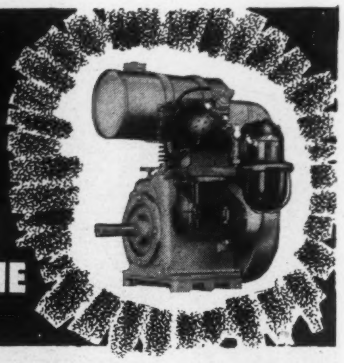

Tremendously increased production capacity for our smaller sizes now enables us to offer our Models AB and AK engines (2 to 4 Hp.) for immediate delivery — in volume to manufacturers of power-operated equipment, or through authorized distributors and dealers on individual purchases.

These are heavy-duty, 4-cycle single cylinder engines that carry "Most Hp. Hours" service ratings. Equipped with tapered roller bearings at BOTH ends of the drop-forged, dynamically balanced crankshaft for long life and protection against bearing failure; high tension outside magneto with impulse coupling for quick, easy starting in any weather; pump-circulated constant level splash lubrication system (no grease cups or oil fittings). Net weight: Model AB, 76 lbs.; Model AK, 77 lbs. Speed range: Model AB, 1600-2600 rpm; Model AK, 1600-2400 rpm.

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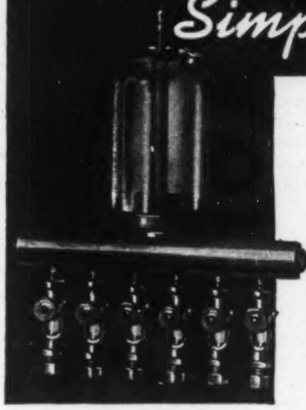

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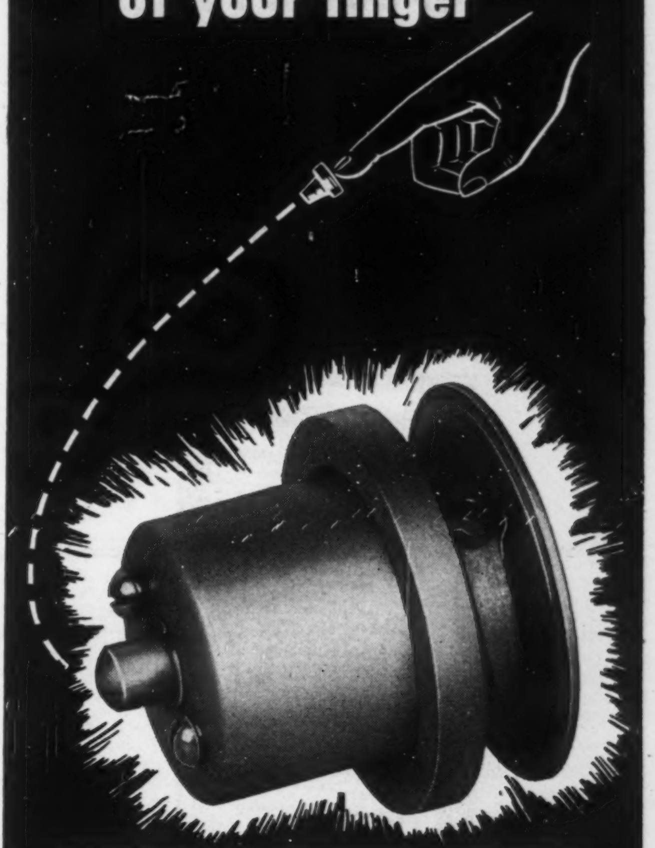

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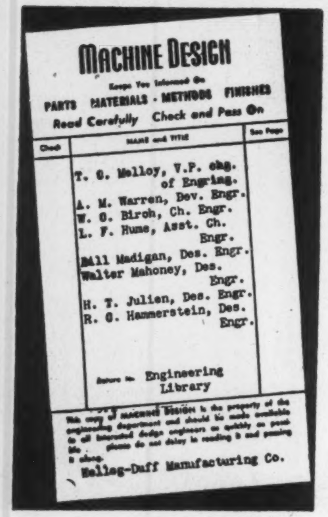

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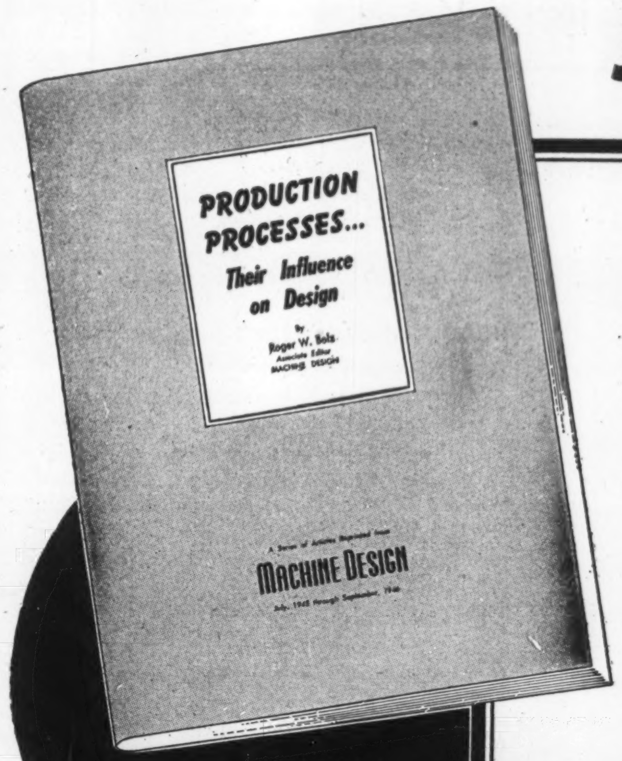

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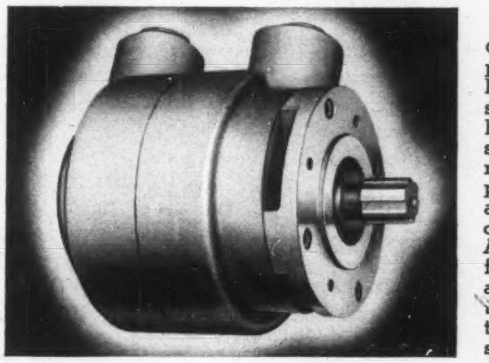

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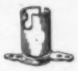

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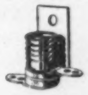

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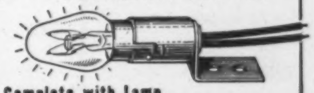

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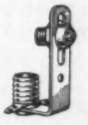

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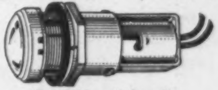

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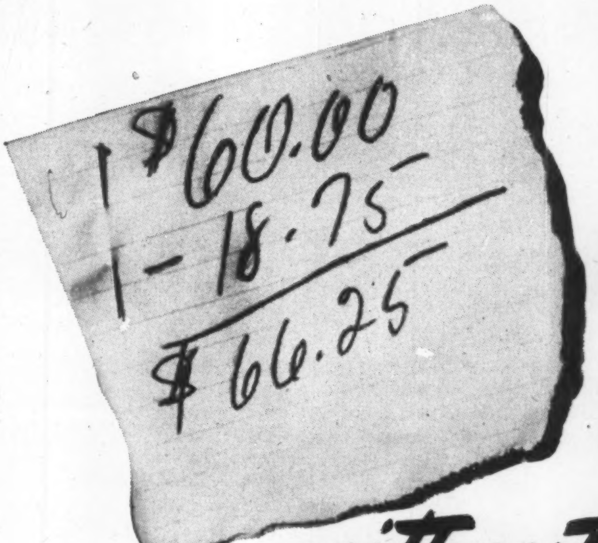

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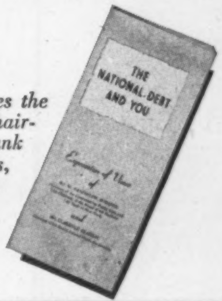


The Treasury Department acknowledges with appreciation the publication of this message by

MACHINE DESIGN

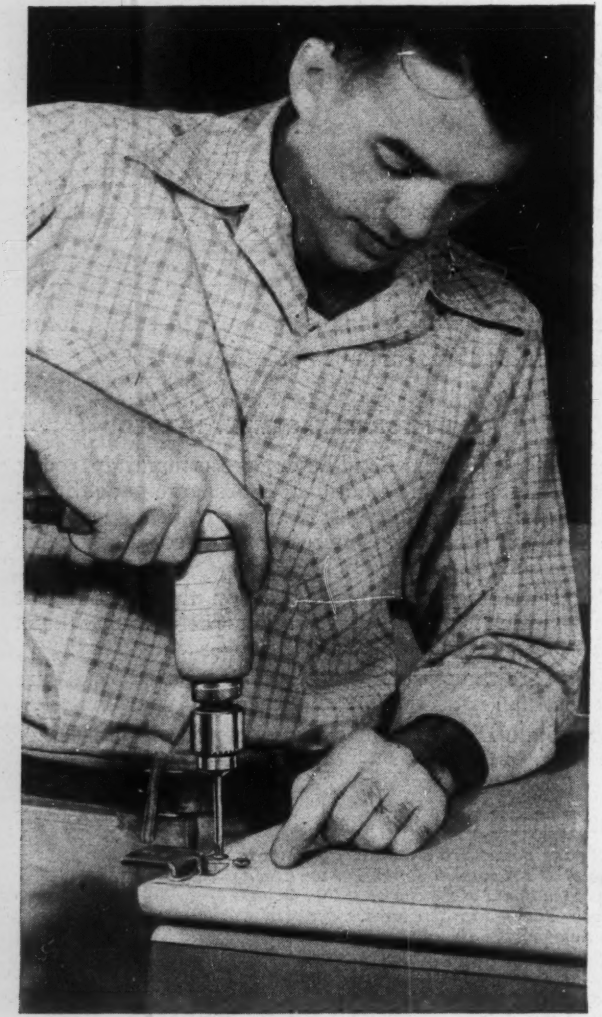
This is an official U.S. Treasury advertisement prepared under the auspices of the Treasury Department and the Advertising Council

"We can set 'em up tight without 'skids' ...make a stronger assembly"

say the makers of *American* KITCHENS STYLED IN STEEL

High-spots from full report of independent investigator of James O. Peck Co., studying assembly savings made in leading plants with Phillips Screws.

★



"HINGES are the weak spots in many kitchen cabinets," explained the purchasing agent for American Central Div.–Avco Mfg. Corp., "But on ours, the hinge is a point of strength, mainly because we use Phillips Screws.

"**Tighter Set-up** is easy with Phillips Recessed Head Screws. But it's difficult to get the same firm 'bite' in sheet metal with slotted screws because the driver doesn't have the same purchase in the slotted screw as it has in the Phillips Recess. And slotted heads would burr . . . make dangerously sharp edges to cut hands and arms, snag clothing.

"**Protects Panels from Driver Gouges.** We don't have to worry about driver slippage with Phillips Screws. No patching or repainting to interrupt our assembly.

"**Quicker Location of Screw** steps up assembly. The instant seating of the driver in the Phillips Recess gets the screw going faster, — and straight, sure driving without worry about slips speeds the whole operation".

Your Assembly Operations Can Benefit by ideas in this report on the American Central Div.–Avco Mfg. Corp. methods, and other reports of assembly studies . . . covering metal, wood, and plastic products. Use coupon.

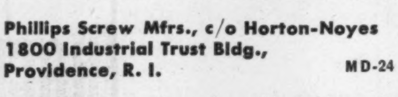
This is an American Kitchen Cabinet door, getting a hinge that won't loosen in years of opening and closing . . . thanks to the ease with which Phillips Screws can be set up tight without burring, and without driver slips that would gouge the highly finished panel.

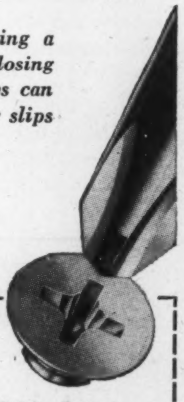
PHILLIPS *Recessed Head* SCREWS

Wood Screws • Machine Screws • Self-tapping Screws • Stove Bolts

24 SOURCES

American Screw Co.
Central Screw Co.
Continental Screw Co.
Corbin Screw Div. of
  American Hdwe. Corp.
Elco Tool & Screw Corp.
The H. M. Harper Co.
International Screw Co.
Lamson & Sessions Co.
Milford Rivet and Machine Co
National Lock Co.
National Screw & Mfg. Co.
New England Screw Co.
Parker-Kalon Corporation
Pawtucket Screw Co.
Pheoll Manufacturing Co.
Reading Screw Co.
Russell Burdsall & Ward
  Bolt & Nut Co.
Scovill Manufacturing Co.
Shakeproof Inc.
The Southington Hardware Mfg. Co.
The Steel Company of Canada, Ltd.
Sterling Bolt Co.
Stronghold Screw Products, Inc.
Wolverine Bolt Company

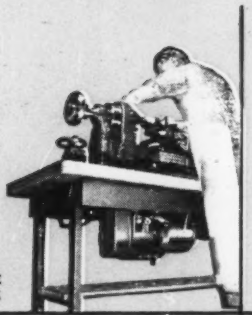




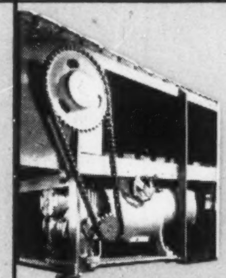
Phillips Screw Mfrs., c/o Horton-Noyes
1800 Industrial Trust Bldg.,
Providence, R. I. MD-24

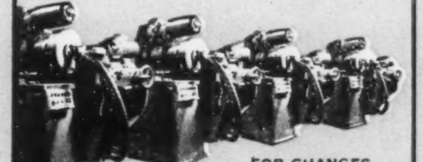
Send me reports on Assembly Savings with Phillips Screws.

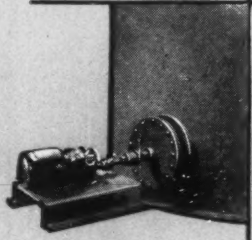
Name..........
Company..........
Address..........

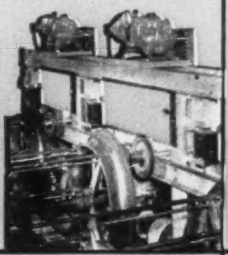

FOR WIDE RANGE OF WORK

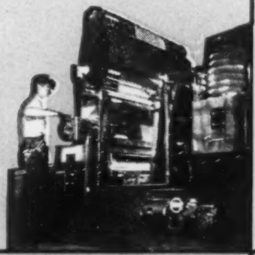
FOR CHANGES IN VISCOSITY


REGULATES CONVEYOR SPEEDS

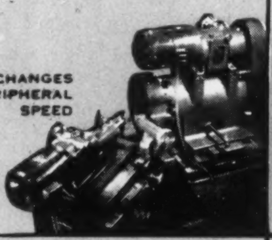

FOR CHANGES IN DIAMETER

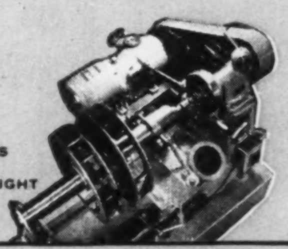

FOR CHANGES IN TEMPERATURE

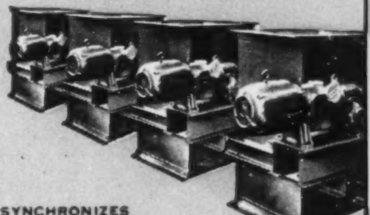

MAINTAINS CONSTANT TENSION

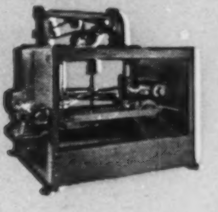

MAINTAINS LINEAL SPEEDS

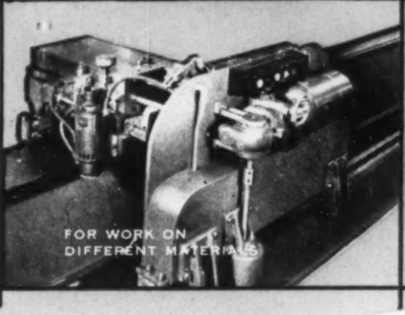
FOR CORRECT POSITIONING

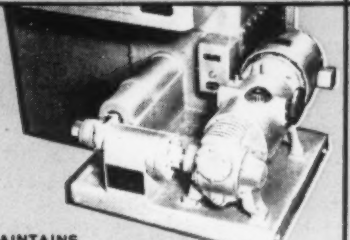

CHANGES PERIPHERAL SPEED


CHANGES IN SIZE AND WEIGHT


SYNCHRONIZES MACHINES IN SERIES


TEXTILE MACHINERY


FOR WORK ON DIFFERENT MATERIALS

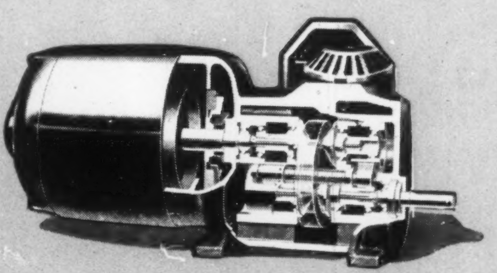

MAINTAINS CONSTANT PRESSURE

These are only a few of the many types of applications where Master Speedrangers are providing the correct range of variable speed for every operation . . . for every operator . . . or for each change in the consistency or shape of the material being processed.

Such variable speed operation pays off in higher rates of production, a better quality product and more efficient performance of your equipment and your operators.

Write for Data 7525 . . . its 24 pages will show you how the compact, all metal construction of Master Speedrangers makes it easier for you to enjoy the many advantages of variable speed operation.

THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO



Bullard Man-Au-Trol gets precision and rigidity with Timken bearings

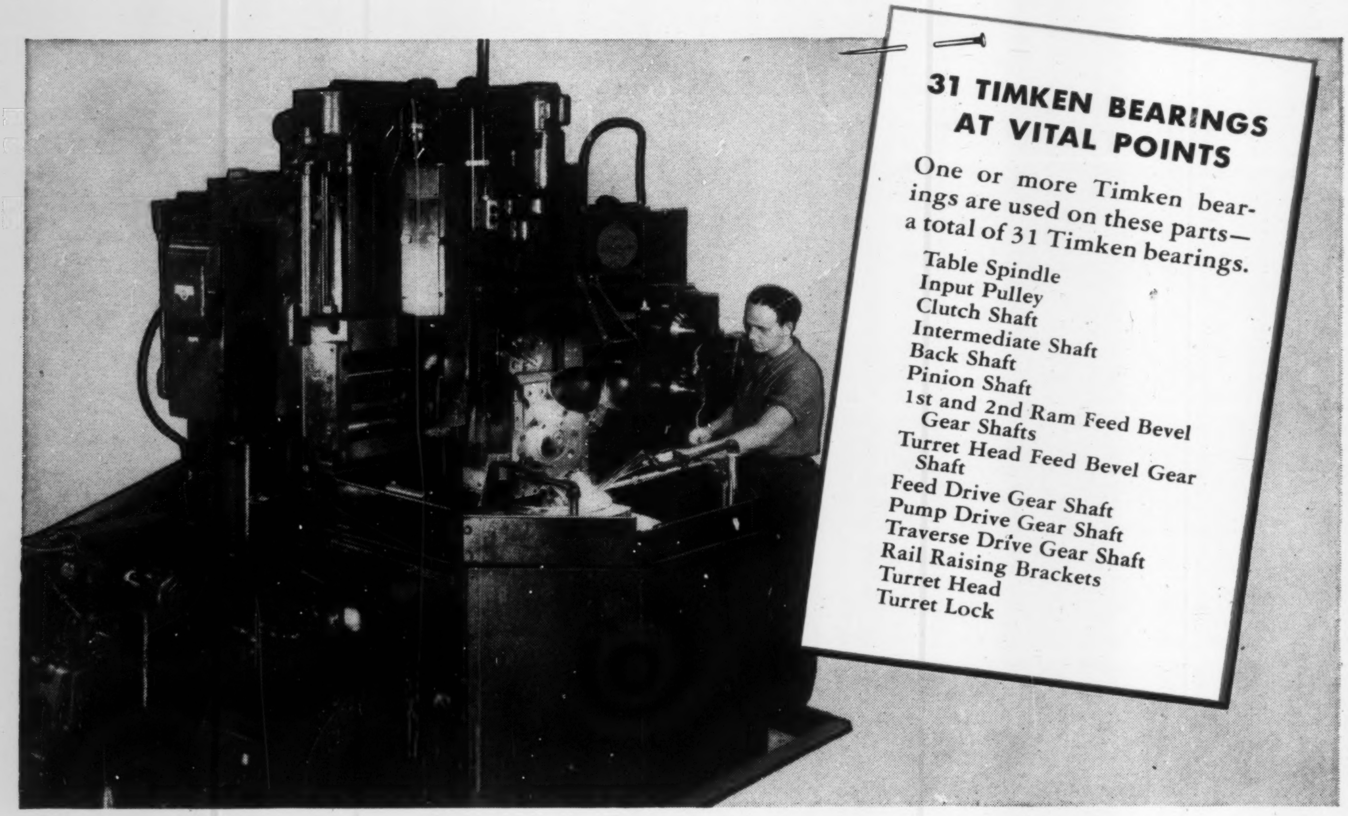
TREMENDOUSLY heavy cuts, high speed automatic operation . . . two big reasons why absolute rigidity and precision are necessary in the Bullard Man-Au-Trol Vertical Turret Lathe. How does Bullard get them? With Timken bearings.

Timken bearings on the work table and throughout the drive of this outstandingly successful machine keep gears and shafts absolutely rigid, yet free to rotate with minimum friction. Maximum support is provided by the line contact between the tapered rolls and races of the bearings. Work table precision is further insured because the Timken bearing is a "Generated Unit Assembly"—no need for breaking-in or final adjustment on the job. The Timken fine alloy steel used in Timken bearings makes the bearing normally outlast the machine itself. Due to their tapered construction, Timken bearings can be accurately pre-loaded.

Whatever type of machine tool you buy or build, it can benefit from the increased rigidity and precision Timken bearings make possible. And remember, no other bearing can give you *all* the advantages you get with Timken bearings, The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN BEARING EQUIPPED

This symbol on a product means its bearings are the best.



31 TIMKEN BEARINGS AT VITAL POINTS

One or more Timken bearings are used on these parts—a total of 31 Timken bearings.

Table Spindle
Input Pulley
Clutch Shaft
Intermediate Shaft
Back Shaft
Pinion Shaft
1st and 2nd Ram Feed Bevel Gear Shafts
Turret Head Feed Bevel Gear Shaft
Feed Drive Gear Shaft
Pump Drive Gear Shaft
Traverse Drive Gear Shaft
Rail Raising Brackets
Turret Head
Turret Lock

TIMKEN
TIMKEN

POSITIVE ROLLER ALIGNMENT

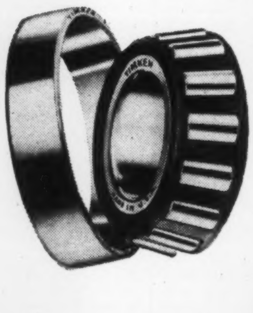
Rollers of Timken bearings are prevented from skewing by the wide area contact between roll ends and rib of the cone . . . a Timken Roller Bearing Company development. Result: bearings roll easier, last longer.

The Timken Roller Bearing Company is the only bearing manufacturer in the country which makes its own steel, and is the acknowledged leader in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis steels.

TIMKEN

TRADE MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL AND THRUST → ← LOADS OR ANY COMBINATION